Seabird Colonies Background Report

for the

Haida Gwaii/Queen Charlotte Islands

Land Use Plan

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ABSTRACT

This report describes the distribution and abundance of nesting seabirds in Haida Gwaii/Queen Charlotte Islands. Traditional uses of seabirds are briefly reviewed and threats to the birds are discussed. The region supports approximately 1.5 million breeding seabirds with 12 species nesting on more than 200 islands, islets and rocks. About one half of the global breeding population of Ancient Murrelets and one fifth of the world's breeding Cassin's Auklets nest in the archipelago. Introduced mammalian predators pose the most serious threat to nesting seabirds of Haida Gwaii/Queen Charlotte Islands. Recreational activities and habitat loss and degradation are other land-based issues of concern. Recommendations for the management of seabird colonies sites are provided.

Photo Credit - Front Cover: Mark Hipfner, Canadian Wildlife Service. Looking south from Cape St. James lighthouse over the Kerouard Island group, site of the only confirmed Common Murre nesting colonies on Haida Gwaii/Queen Charlotte Islands, 2004.

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INTRODUCTION

Seabirds spend most of their year on marine waters and, in general, come to land only to breed. Most species nest in colonies located on islands. Approximately 1.5 million seabirds from 12 species nest on the islands of the Haida Gwaii/Queen Charlotte Islands archipelago. Nests have been recorded on more than 200 offshore islands, islets and rocks as well as on Graham and Moresby Islands. This report describes the known distribution and abundance of seabirds breeding in the region to aid the Haida Gwaii/Queen Charlotte Islands Land Use Planning table in its discussions. Issues of concern for local nesting seabirds are presented and some management options are recommended.

This background report is not intended to be an exhaustive review of seabirds in the region. Key review papers are noted throughout the document as an aid to those readers who wants to learn more about the topics presented here.

The marine waters surrounding Haida Gwaii/Queen Charlotte Islands support the seabirds that breed on the islands as well as millions of additional seabirds. Included are non-breeding individuals of species that nest in the region and seabirds that breed in other regions such as Alaska or New Zealand and migrate through, or overwinter in, coastal waters of the archipelago. Although these non-breeding birds are not the focus of this report, readers should be aware of them when considering the ramifications of management of the land base. The species and their marine habitats are described in Harfenist *et al.* (2002). The oceanographic processes and features that most likely influence the distribution and abundance of seabirds on the ocean, such as currents and seamounts, are briefly reviewed by Burger *et al.* (1997). A review of the distribution and abundance of seabird prey species in the waters around the archipelago can be found in Robinson *et al.* (1999).

TRADITIONAL USES OF SEABIRDS

A complete account of the role of birds in Haida life prior to contact can not be reconstructed. However, the significance of seabirds in the diet, ceremonies, stories and songs from pre-contact times through the early 20th century has been documented during interviews with Haida Elders born in the

late 1800s (Blackman 1979, 1990; Ellis 1991) and in archaeological excavations (Acheson 1998; Fedje *et al.* 2001). The following information was taken from those sources.

Eight of the twelve species of nesting seabirds covered in this report and/or their eggs were traditionally hunted or collected by the Haida. These are: Pelagic Cormorant, Glaucous-winged Gull, Common Murre, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet and Tufted Puffin. Seabirds and their eggs provided seasonally abundant sources of food. Small alcids, predominantly Ancient Murrelets and Cassin's Auklets, dominated the diet during the nesting season and nesting colony locations were well known. Birds and eggs were dug out of burrows or hunted at night using light and noise to disorient the birds. The larger alcids were taken less frequently as they were less abundant and nested in less accessible sites. Storm-petrels were considered too small to eat. Glaucous-winged Gull eggs were of sufficient importance that nesting sites were inherited property of specific lineages. Although few seabirds are hunted in modern times, collection of gull eggs still occurs at some sites in Skidegate Inlet (B. Wilson, Gwaii Haanas, *personal communication*).

Seabird parts were also used as tools and adornment . Bones were used as tools and drinking straws. Pigeon Guillemots and Marbled Murrelets were carved onto halibut hook floats to bring good luck. Puffin beaks were used as decoration or rattles.

The significance of seabirds in Haida life is evident from their incorporation into songs and stories. For example, a song sung by Northern Haida celebrated the return of Ancient Murrelets and Cassin's Auklets to the nesting grounds. According to a legend recounted by Skidegate Elders, the gargling sound of the Pelagic Cormorant is a result of a trick played on him by Raven who was jealous of the cormorant's fishing ability.

NESTING SEABIRDS OF HAIDA GWAII/QUEEN CHARLOTTE ISLANDS

Approximately 1.5 million seabirds of 12 species nest in Haida Gwaii/Queen Charlotte Islands including:

- 2 species of storm-petrels: Fork-tailed Storm-petrel; Leach's Storm-petrel
- 1 species of cormorant: Pelagic Cormorant
- 1 species of gull: Glaucous-winged Gull
- 8 species of alcid: Common Murre; Pigeon Guillemot; Marbled Murrelet; Ancient Murrelet; Cassin's Auklet; Rhinoceros Auklet; Horned Puffin; Tufted Puffin

The Haida and scientific names for these species are listed in Appendix 1.

None of these species nests only in Haida Gwaii/Queen Charlotte Islands, but breeding sites for most of them are confined to the coastlines of the northern Pacific Ocean. The archipelago supports significant proportions of the global nesting populations of Ancient Murrelets and Cassin's Auklets.

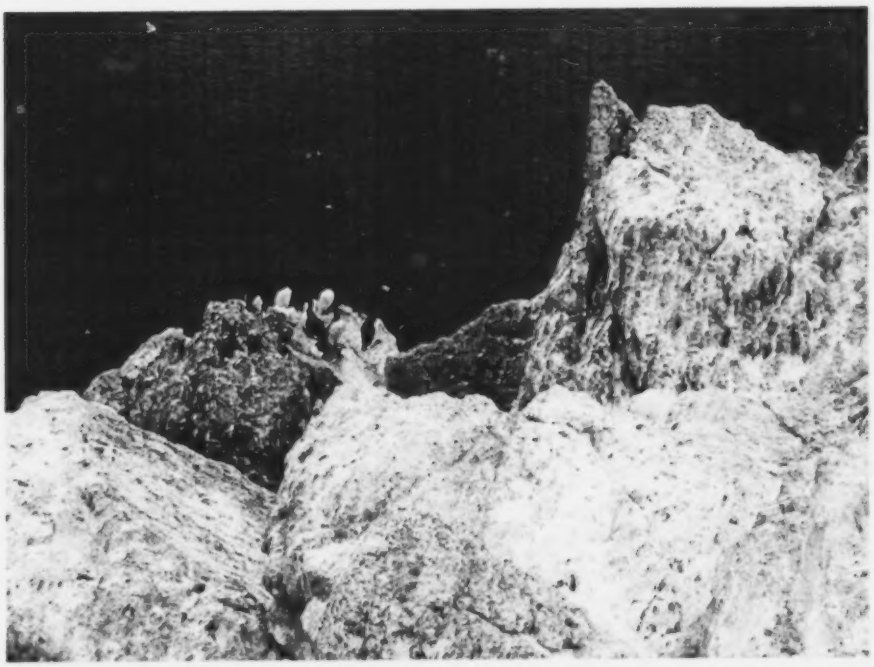
Site Accounts

In Haida Gwaii/Queen Charlotte Islands, the vast majority of seabirds nest on islands off the northwest coast of Graham Island and the northwest, south and east coasts of Moresby Island. Numerous sites with small numbers of Glaucous-winged Gulls and Pigeon Guillemots are also found in Skidegate and Masset Inlets. All known seabird nesting islands, islets and rocks in the archipelago are listed in Table 1. Those site names that appear in quotation marks are names given by seabird survey crews and are not gazetted or official names. Locations are shown in Figures 1a, b, c and d.

Some of the sites listed in Table 1 are groups of islands. For example, SGaang Gwaii (Anthony Island) is comprised of 27 islands and islets. In such cases, the breeding populations in Table 1 are presented for the entire island group. Details on the nesting populations of each islet are available for many of these sites (Campbell 1975; Hatter and Stordeur 1978; Rodway 1988; Rodway *et al.* 1988, 1990, 1994; Vermeer *et al.* 1991, 1993).

Table 1 also lists the estimated breeding populations of each species at each site. The quality of those population estimates varies with species and site. Estimates of most burrow-nesting species (Fork-tailed and Leach's Storm-petrels, Ancient Murrelets, Cassin's Auklets, Rhinoceros Auklets) are notably imprecise and the numbers given for Tufted and Horned Puffins are little more than guesses. Furthermore, the vast majority of the estimates are about 20 years out-of date. The main exceptions are: data for gulls and guillemots at most sites in Skidegate Inlet are from the early 1990s; alcid colony estimates from Englefield Bay (Helgesen, Little Helgesen, Lihou, Instructor), Langara, Frederick, Kunghit, Gordon, Charles, George, Lyell, East Limestone and Reef are derived from surveys done in the 1990s; and counts of gulls in Laskeek Bay (Lost, Kingsway, Reef, Low, Skedans, Cumshewa) and cave-nesting cormorants are from 2000. Additional problems with the population estimates are noted in the species accounts below.

Ancient Murrelet adult and chick (Laskeek Bay Conservation Society)



Common Murres, Kerouard Islands, 2004 (Mark Hipfner)

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
Hunter Pt.						2						
"Gudal Bay" Rks.						9						
Stiu Rk.					40	5						
Stiu Pt.				30 birds								
Gagi Rk.					43	2						
Marble I.				h	37	20		1,000	5,000	200	300	5s
"Cape Naden" Rks. #2					32	80						
"Cape Naden" Rks. #3					78	70						
"Klashwun" Rks. (3)					3	20						
Moresby I. – east and west coasts												
Battle I.	s	300				s						
Buck Channel				75 birds								
E. of Annesley Pt.				30 birds								
Saunders I.					7	10		50	x	x		
"Little Helgesen" I.	200							900		x		
Helgesen I.	s							1100	200	3,300		
Willie I.	x	x				30		10s	200	80		
Carswell I.			300s					1,700	c	20		
"Inskip" Cave				8 birds								
Instructor I.			1600			20		x		x		
Lihou I.			13,000	10 birds		80		12,000	13,000	2,800	30	
Bone Pt.				h	20	30					10	
Luxmoore I.			6,000			2		1,000	400	300		
Rogers I.			29,000			20		1,700	40	20		
Cape Kuper								10	100	10		
Moresby Its. (2)					1	1		1s	80	40		
Bottle Pt.				18 birds								
Chads Pt.				30 birds								
Ariel Rk.					1	1			80			
Lomgon Its.					34	10						
Horn Rk.					3							

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
S. of Tasu Head				20 birds								
Blue Heron Bay S.				70 birds								
Kwoon Cve S.				18 birds								
Pocket Inlet N.				38 birds								
"Mike" Rk.					7							
"Cone" It.			s			8	a				60s	
"Between" It.					6	2			100s			
"Goski Bay" Its.					1	5						
Nangwai Is.	2				1	8						
Gowdas Is.					21	20						
S. of Wells Cove				35 birds								
"Victoria" Rk.					19	3						
"Keyhole" Rk.					11							30s
"McLean Fraser" Pt.				16 nests	5	2						
Adam Rks. (4)					48	20					4s	
SGaang Gwaii (28)			11,000	7	350	400	a	200	25,000	14,000	30	20
Flatrock I.				h	150	20					20	2
Gordon Is. (3)			9		1	30			600	100		
St. James I.					76	20			x		200	2s
Kerouard Is. (3)					75	70	0 - 400		78,000		900	
Kunghit I.				35	29	200		3,600	4	2,500	300	
N. of Treat Bay				40 birds								
Marshall I.						30						
Gull It.					1	8						
Rainy Is. (4)			100s		26	20						
High I.						8		x		6		
Haydon Rk.					1							
Ellen I.			x							x		
Charles Is. (2)	100					20			10	90		
Annette I.						10				20		
Garcin Rks.					100	6						
Langtry I.			12,000			6						

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
Samuel Rk.					5	10						
Rankine Is. (2)			14,000		43	10		26,000	26,000			
Marion Rk.					1							
Nest Its. (2)						30						
Joyce Rks. (5)					200	9						
Boulder I.								x				
Sea Pigeon I.						5		x				
Green Rk.					3	20						
"Jedway" Rk.						1						
Bush Rk.						1						
Bolkus Is. (12)			200s		1	40		9,900	1,000	20		
Swan Is. (3)					1	4						
"Pelican" Rk.					2							
Slug It.					48	5						
Rock Its. (10)			17,000		1	6			5,100			
Skincuttle I.			4,300					2,200	1,000			
George I.	s	400						17,000	4,300			
Jeffrey I.								1,000	2,700			
East Copper I.			50					4,400	11,000			
Burnaby I.						3 nests						
Howay I.	10s			19	10	4		300	300			
"Poole Inlet" It.				h	12	c		s				
"Kat" Rks. (2)					6	30						
Centre It.						20						
Wanderer I.						40						
Sels It.	x					40						
Park I.						30						
Koga I.						40						
Alder I.			60s			2		14,000	3,200			
Huxley I.						10						
Arichika I.	x	x				7		x	x			
Marco Rk.					18	30						
Hutton I.						10						
Hoskins Its. (2)	x					90						
Tatsung Rk.					11							
Ramsay I.				28 birds	16	30		18,000	13,000			
Ramsay Rks.					5							
Bischof Is. (6)			50			20		x				

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
Hotspring I.			900			30		6	10			
House I.						30		2,700	40			
Murchison I.				15	27	30		20	50			
Murchison Rk.					6							
Agglomerate I.			5,500		2	10		2,200	200			
Kawas Its. (5)			700		11	5			200			
Tar Is. (11)			300	22 birds	32	50		x	100			
Skaga I.						c						
Tuft Its.					4						x	
Lyell I. (Dodge Pt.)				3		4		8,300				
Topping I.					15							
Gil It.					1							
Kul Rks.					11	1						
Kelo Rks.					2	10						
Titul I.						100			200			
Lost Is. (2)	80	c			180	6			200			
Helmet I.				h		20						
Proctor Rks.						3						
Kingsway Rk.					48	70						
Reef I.	100			11	2	300		5,000	1,700	c		
South Low I.					20	20						
Limestone Is. (2)	c					70		1,500	40	2		
Low I.	200				8	450			30			
Skedans Is. (5)	1100				3	140			100			
Haswell I.	x				x							
Vertical Pt.				h		7						
Louise I.				h								
Mabbs It.						60						
Nedden I.						170						
Oliver It.						2						
Kingui I.	x					4						
Cumshewa I.					0	60						
Skidegate Inlet												
Gillat I.					40	60						
Torrens I.						500						
Jewell I.						300						
Flowery It.					21							

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
"Kwuna" Rks. (2)					12	20						
"Alliford" Its.					2	500						
Bush I.					12	60						
Lillihorn I.					10	50				c		
Sandilands I.						6						
Maude I.						1						
Tree It.					1	60						
Maple I.					7	100						
Balch Is. (3)					4	80						
Gooden I.						60						
Roderick I.						5						
Angle I.					1	200						
Unnamed 1						8						
Unnamed 4						50						
Unnamed 6					1							
Unnamed 10						70						
Unnamed 11						2						
Unnamed 12						2						
Unnamed 13 (NW of Claudet I.)						10						
Claudet I.						100						
Claudet It.						20						
Burnt I.					2	50						
Burnt Its.					1	200						
"Dyer Pt" Rks.					2							
Meyer I.					2	40						
Legace I.						3						
Treble I.						20						
Hallet I.					1							
Scalus I.						8						
Anthracite Pt.						1						
Sandstone Is.						30						
Gust I.						1						
Masset and Juskatla Inlets												
Sloop It.					2							
Dawson Is. (4)					32	20						

Site[b]	Fork-tailed Storm-petrel	Leach's Storm-petrel	Unidentified Storm-petrel	Pelagic Cormorant[c]	Glaucous-winged Gull	Pigeon Guillemot	Common Murre[d]	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	Tufted Puffin	Horned Puffin
"Kwaikans" Rks. (4)					6							
McCreight Is.					4	20						
"Mutus" Rks. (4)					1	3						
"Learmonth" Rks. (3)					2	2						
Ross It.					c	2						
Powell I.					12	4						
Cowley Is. (2)					19	60						
Ohala Its.					1	4						
Steilta Its. (6)					1	100						
Seegay Its. (3)						2						
Modeets Is. (3)					1	2						
Mamin Its. (4)					2							
Harrison Is. (2)					1	30						

[a] Data from Summers 1974, Campbell 1975; Hatter and Stordeur 1978; Rodway 1988; Rodway *et al.* 1988, 1990, 1994; Vermeer *et al.* 1991a, 199b, 1993; Gaston and Lemon 1996; Lemon 1997, Harfenist 1994; Gaston and Masselink 1997; Smith 1998, Gray 1999, 2000; Lemon and Gaston 1999; Butler 2000; Carter *et al.* 2001; D. Burles, *unpublished data;* M. Chutter, *unpublished data;* A. Gaston, *unpublished data;* A. Harfenist, *unpublished data.* Because of the imprecise nature of the estimates for burrow-nesting seabirds, figures > 10 for Fork-tailed and Leach's Storm-petrel, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin and Horned Puffin have been rounded off.

[b] Names in quotation marks are not official or gazetted names – the names were given by seabird survey crews. Numbers in parentheses indicate number of islands/islets/rocks within the island group described by seabird surveyors. Shaded sites are located within Gwaii Haanas National Park Reserve/Haida Heritage Site, an Ecological Reserve or a Wildlife Management Area.

[c] Pelagic Cormorant estimates are given as number of occupied nests unless otherwise noted. At many sites, the estimates are the number of birds flushed from caves and nesting could not be confirmed. "h" = historical: the last recorded count was done prior to 1980. Note that it is not unusual for cormorants to exhibit wide fluctuations in numbers of nesting pairs between years - estimates at Murchison have varied between 0 and 100 pairs.

[d] Sites with murres attending but breeding not confirmed are listed as "a".

Figure 1 a. Map of northern Haida Gwaii/Queen Charlotte Islands showing place names mentioned in the text and tables.

Figure 1 b. Map of southern Haida Gwaii/Queen Charlotte Islands showing place names mentioned in the text and tables.

Figure 1 c. Map of Skidegate Inlet, Haida Gwaii/Queen Charlotte Islands, showing place names mentioned in the text and tables.

Figure 1 d. Map of Masset and Juskatla Inlets, Haida Gwaii/Queen Charlotte Islands, showing place names mentioned in the text and tables.

Further information on nesting habitats and densities on most of the islands in Haida Gwaii/Queen Charlotte Islands is available in Canadian Wildlife Service technical reports summarizing survey results (Rodway 1988; Rodway *et al.* 1988, 1990, 1994; Harfenist 1994) with updates for some sites in Laskeek Bay Conservation Society annual reports (Lemon 1992, 1993 a, b, 1997; Gaston and Lemon 1996; Smith 2000) and other papers (Gaston and Masselink 1997).

Species Accounts

The following information is presented for each of the 12 species of seabirds that nest in Haida Gwaii/Queen Charlotte Islands:

- Brief overview of the species' ecology;
- Breeding population estimates and trend information;
- Nest site locations;
- Significance of local breeding population on a provincial and global scale; and
- Special conservation status.

Notes on timing of nesting should be considered as general estimates only. Timing varies between years and between regions of the archipelago.

Trend data are available for many seabird colony sites after the 1960s. In general, seabird populations may have increased post-European contact as Haida populations declined and diets changed (Kaiser 2002). Seabirds now nest at former Haida village and summer camp sites and are rarely hunted for food.

Provincial, federal and international listings of special conservation status are noted where applicable and these are from the Conservation Data Centre (CDC; Victoria), Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Ottawa) and World Conservation Union (IUCN; Switzerland), respectively.

Further information on the species' ecology and population trends in Haida Gwaii/Queen Charlotte Islands can be found in Vermeer *et al.* (1997) and Harfenist *et al.* (2002). The global ecology and distribution of each species are reviewed by Poole and Gill (1997) and, for the alcids, by Gaston and Jones (1998).

Fork-tailed Storm-petrels and Leach's Storm-petrels

Storm-petrels nest colonially in burrows found mainly on small, forested islands. Breeding pairs lay a single egg which is incubated for about 50 days. Fork-tailed Storm-petrels nest about two months earlier than Leach's Storm-petrels: off the west coast of Graham Island, the average hatch date of Fork-tailed Storm-petrels is mid-June whereas that of Leach's Storm-petrels is mid-August (Vermeer *et al.* 1988). After hatching, parents feed their chick in the burrow for about 60 days before the chick fledges. The main prey are larval fish and invertebrates that are picked off the ocean surface. Trips to and from the colonies are made in darkness. Storm-petrels are usually found in offshore marine waters and are only rarely seen on the water around their colonies during the breeding season.

An estimated 53,000 pairs of Fork-tailed Storm-Petrels and 103,000 pairs of Leach's Storm-Petrels nest in Haida Gwaii/Queen Charlotte Islands (Rodway 1991). These estimates should be used with caution because storm-petrels tend to nest in mixed species colonies and the proportion of each species was not determined during some surveys. The locations and sizes of Fork-tailed and Leach's Storm-petrel colonies are shown in Figures 2 and 3, respectively. Figure 4 shows the locations and sizes of colonies at which the storm-petrels were not identified to species. The archipelago supports about 21% of the British Columbia breeding population of storm-petrels (Rodway 1991). The estimated totals for each species represent approximately 3% of the North American breeding population of Fork-tailed Storm-Petrels and less than5% of the northeastern Pacific breeding population of Leach's Storm-Petrels (Campbell *et al.* 1990 a).

Although population trend data are not available for either storm-petrel species on a regional scale, records indicate that 13 colonies have been abandoned. The historical population numbers and species composition at these sites are not known and most of the desertions (Tian and Hoskins Islets and Ellen, Sels, Arichika, Kingui, Haswell and Willie Islands) remain unexplained. Colonies on Langara and Cox Islands were likely extirpated by introduced rats (Bertram and Nagorsen 1995) and those on Queen, Ogilvie and McKenzie Islands were destroyed by bears (Drent and Guiget 1961). Small storm-petrel colonies have appeared or increased on Frederick, George and Charles Islands since the 1980s (Harfenist 1994, Lemon 1997; A. Harfenist *unpublished data*).

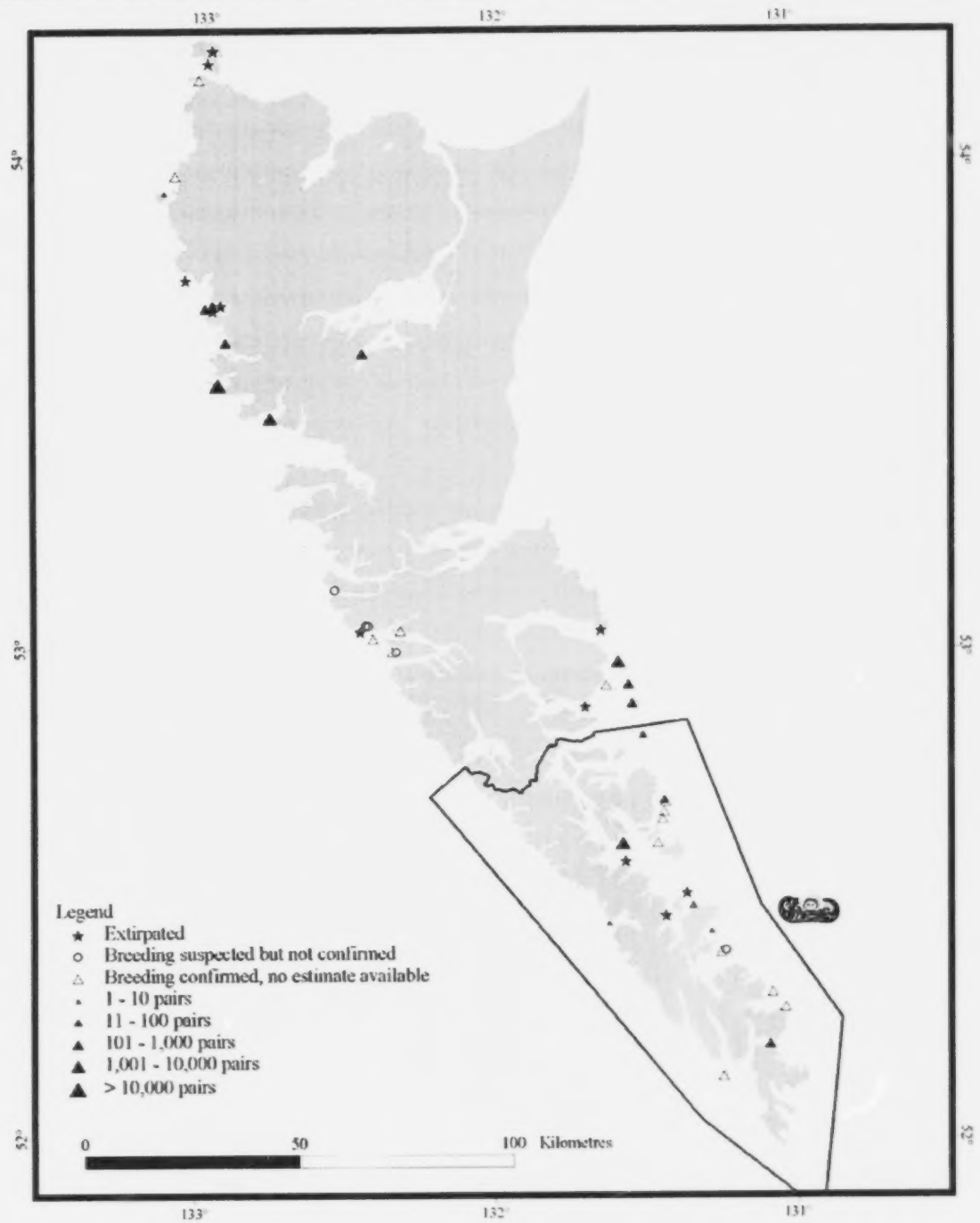


Figure 2. Locations and relative sizes of breeding colonies of Fork-tailed Storm-petrels in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

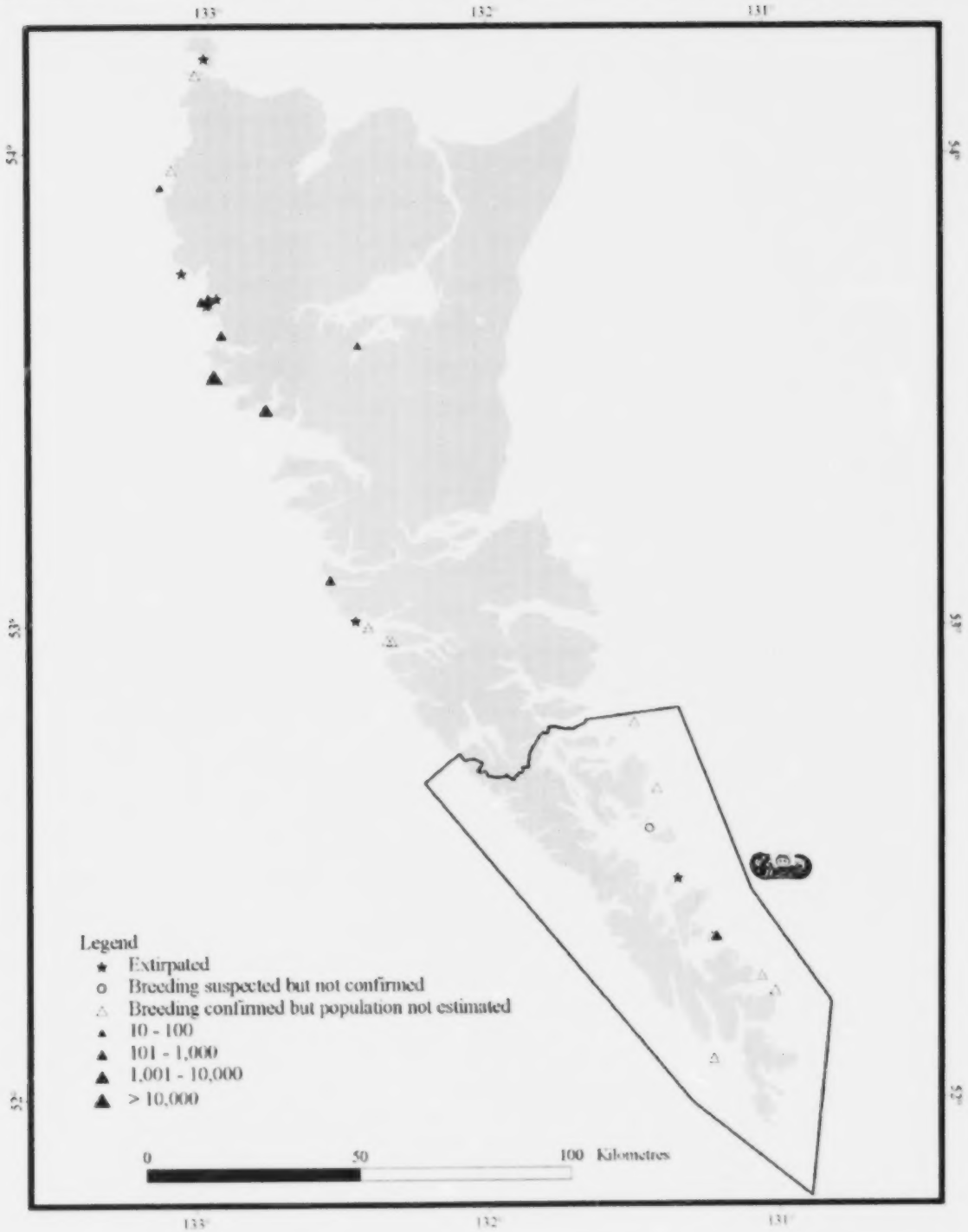


Figure 3. Locations and relative sizes of breeding colonies of Leach's Storm-petrels in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

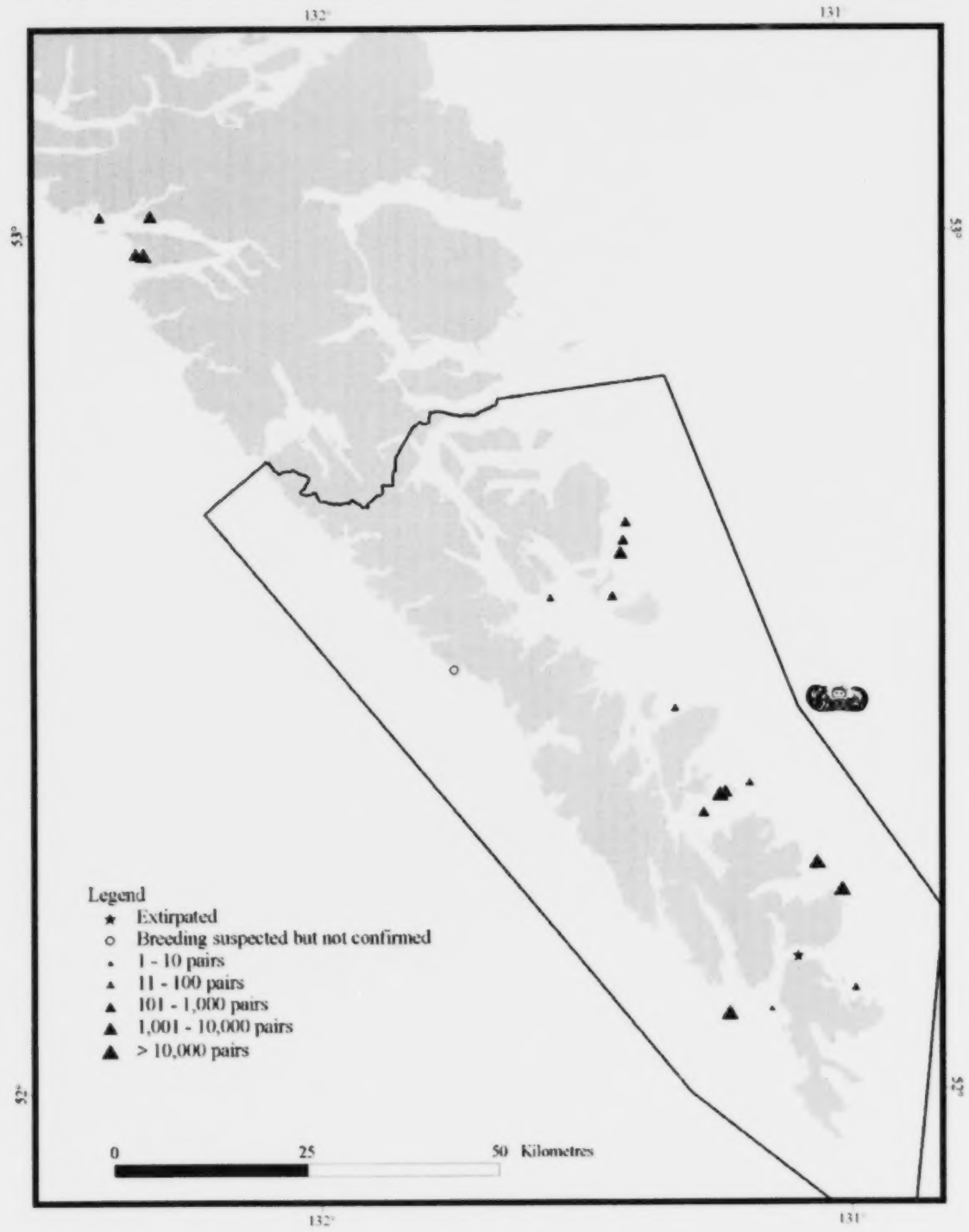


Figure 4. Locations and relative sizes of breeding colonies of storm-petrels in Haida Gwaii/Queen Charlotte Islands at which nests were not identified to species (figure taken from Harfenist *et al.* 2002).

Pelagic Cormorant

Pelagic Cormorants build nests in colonies on cliff ledges and in caves of Graham and Moresby as well as of offshore islands. Most pairs lay three to five eggs. Eggs are incubated for about 30 days. Timing of breeding is not well documented on Haida Gwaii/Queen Charlotte Islands, but elsewhere hatching occurs from mid-June to mid-October with about half of the eggs hatching from mid-July to mid-August (Hobson 1997). After hatching, chicks are fed at the nest for 40-50 days. Pelagic Cormorants feed on bottom fish and trips to and from the colonies are made during the day. Pelagic Cormorants are usually found in relatively shallow (<100 m) inshore marine waters.

The published estimate of 280 pairs of Pelagic Cormorants breeding in Haida Gwaii/Queen Charlotte Islands (Rodway 1988) is very likely low because most cave-nesting pairs were missed during surveys. In 2000, over 400 birds were observed flying from caves at 16 locations previously unidentified as breeding sites (M. Chutter, B.C. Ministry of Water, Land and Air Protection, *unpublished data)*. The number of breeding pairs represented by these cave-nesting cormorants is unknown because the number of nests within the caves usually cannot be determined. The 42 confirmed and probable (cave) breeding sites are shown in Figure 5. The 280 pair estimate for the archipelago represents less than 7% of the British Columbia total and approximately 1% of the North American population (Campbell *et al.* 1990 a).

Rodway (1988) reported a decline between 1977 and 1986 in both the nesting population and the number of colonies in the archipelago. However, trends are difficult to determine because the birds move among breeding sites and cave sites are difficult to survey. Thus, documented local abandonments, declines and increases may reflect birds that have shifted to new nesting sites.

Pelagic Cormorants are provincially red-listed (endangered or threatened) due to recorded declines in population size and number of nesting locations. As noted above, the declines may reflect inadequate survey design rather than real reductions of the population.

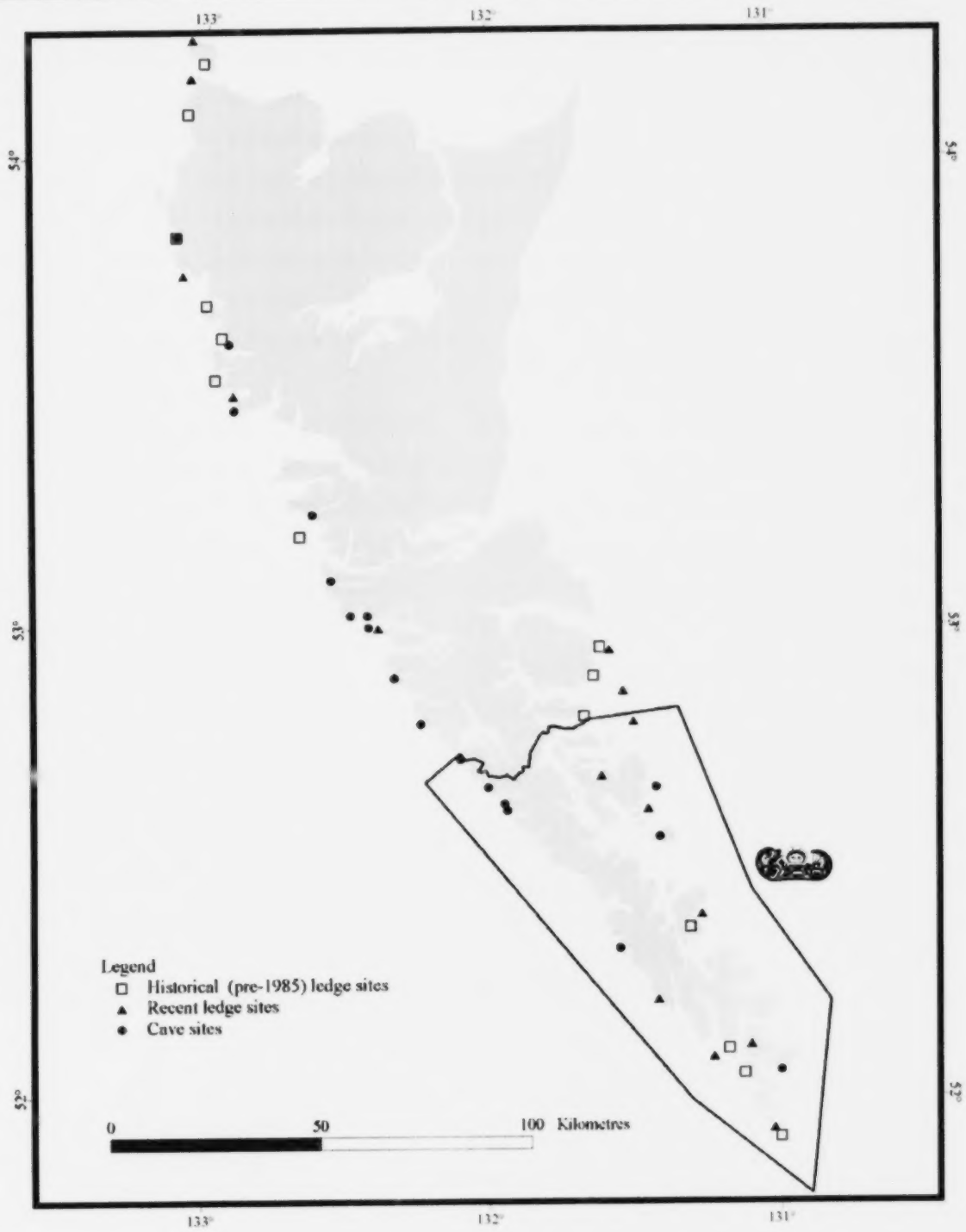


Figure 5. Locations of breeding colonies of Pelagic Cormorants in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Glaucous-winged Gull

Glaucous-winged Gulls build nests on rocky headlands or other open areas of offshore islands. They nest either colonially or solitarily. Gulls lay one to three eggs and incubate the eggs for about a month. Hatching peaks from late June through early July (Verbeek 1993). Chicks fledge at about 57 days of age. The diet consists mainly of fish and invertebrates picked from the ocean surface or intertidal zone, but also includes scavenged carcass parts and garbage. Flights to and from the colonies are made during daylight. Glaucous-winged Gulls are found in both inshore and offshore marine waters and on freshwater lakes.

About 2,800 pairs of Glaucous-winged Gulls nest on Haida Gwaii/Queen Charlotte Islands (Vermeer *et al.* 1997). The locations and sizes of 110 known breeding sites are shown in Figure 6; locations of abandoned colonies are shown as well. The archipelago supports approximately 11% of the British Columbia population and less than 2% of the northeastern Pacific breeding population of this species (Campbell *et al.* 1990 b).

The Glaucous-winged Gull breeding population in Haida Gwaii/Queen Charlotte Islands is probably increasing. The population increased between the mid-1970s and mid-1980s, when the last relatively complete survey was done (Rodway 1988) and numbers breeding in Laskeek Bay have increased since 1992 (Gaston 2002). In coastal British Columbia, the breeding population increased by approximately 350% from 1940-1990 (Campbell *et al.* 1990 b).

Common Murre

In Haida Gwaii/Queen Charlotte Islands, Common Murres nest colonially on cliff ledges. Pairs lay a single egg and incubate for about 33 days. Timing of hatching has not been documented in the archipelago. Chicks stay at the nest for two to three weeks following hatch. Parents feed fish to their chicks during daytime trips made to the colony. Prey are pursued underwater. On the ocean, Common Murres tend to be found in shallow (<100 m) water.

The Kerouard Islands are the only confirmed breeding site of Common Murres in Haida Gwaii/Queen Charlotte Islands. Numbers at the site have fluctuated widely between years: counts

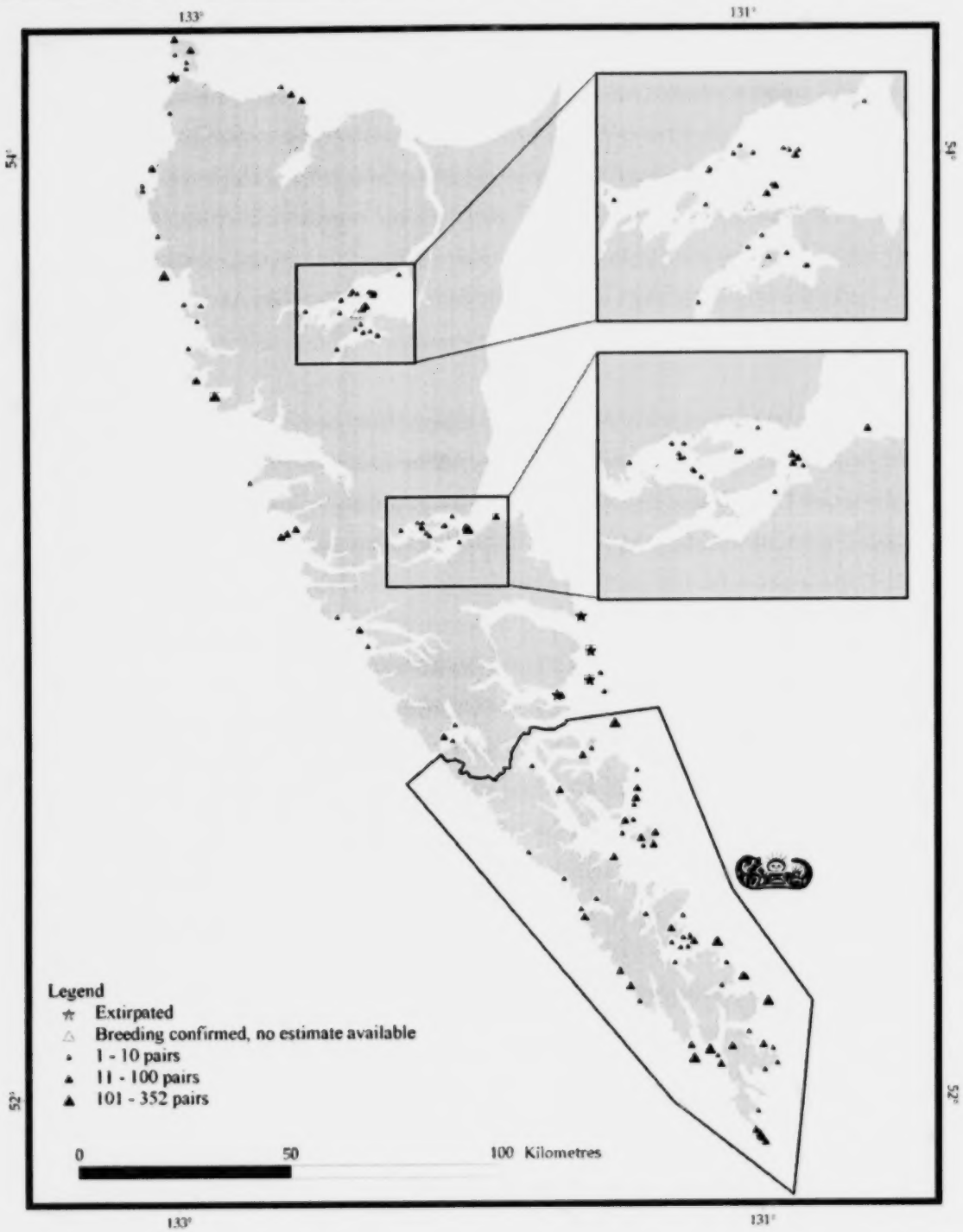


Figure 6. Locations and relative sizes of breeding colonies of Glaucous-winged Gulls in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

have ranged from 0 to 400 (Carter *et al.* 2001). In a recent review, the population of the Kerouards was given as 164 birds (Carter *et al.* 2001). Common Murres have been noted standing on (attending) other islands in the archipelago, but it is unknown whether the birds were nesting at those locations. Confirmed and possible nesting sites are shown in Figure 7. The estimated total for the region represents less than 0.25% of the total for the west coast of North America (Campell *et al.* 1990 b).

Given the large inter-year variability in breeding population size, it will be difficult to determine a population trend for this species.

The Common Murre is red-listed (endangered or threatened) in British Columbia because the concentration of the population at only a few colony sites renders the species extremely vulnerable to catastrophic events such as oil spills. The Pacific subspecies of Common Murre is a COSEWIC candidate species (suspected of being at risk but not yet officially assessed).

Pigeon Guillemot

Most Pigeon Guillemots nests are located in rock crevices or burrows, but may also be found on inshore industrial sites like pilings. Nests tend to be located within 30 m of shore and may be solitary or in colonies (Ewins 1993). Pairs usually lay two eggs but occasionally lay only one. Incubation lasts about 30 days. The timing of hatching is not well described for Haida Gwaii/Queen Charlotte Islands. Following hatching, chicks stay at the nest for about 40 days. They are fed small fish by their parents during diurnal visits. Adults dive for their fish and invertebrate prey. Pigeon Guillemots are predominantly found in inshore marine waters.

Regional Pigeon Guillemot nesting population estimates aren't available because nests are difficult to find. Rodway (1988) counted ~ 5,000 guillemots on the ocean around potential nesting islands in Haida Gwaii/Queen Charlotte Islands, but that figure is a significant underestimate of the number of birds present because of problems with the survey methods used (A. Gaston, *personal communication*). The locations and counts of Pigeon Guillemots are shown in Figure 8. The archipelago supports approximately 50% of the British Columbia population of Pigeon Guillemots and 6% of the world population (Ewins *et al.* 1993; Rodway 1991).

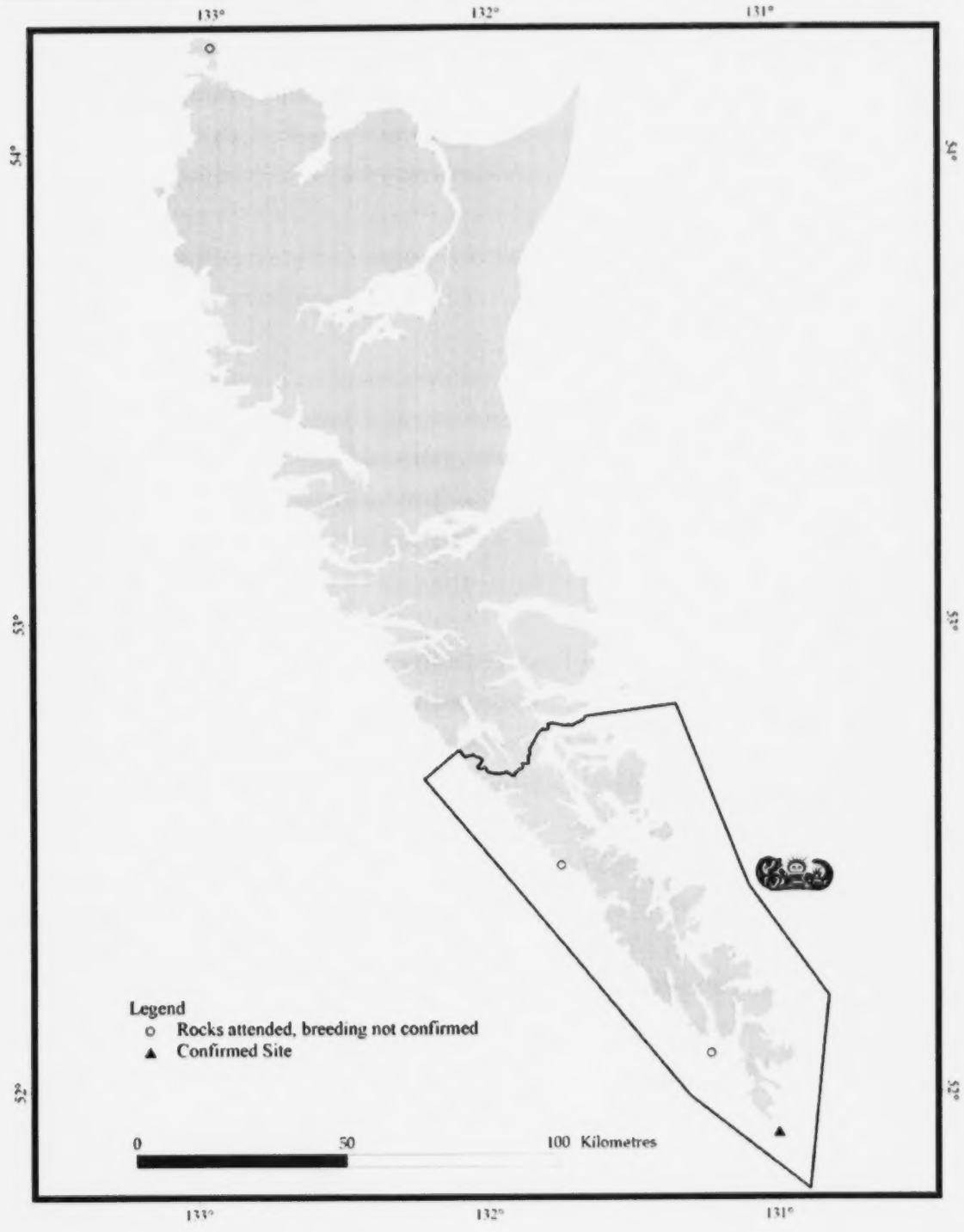


Figure 7. Locations of confirmed and possible Common Murre breeding colonies in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

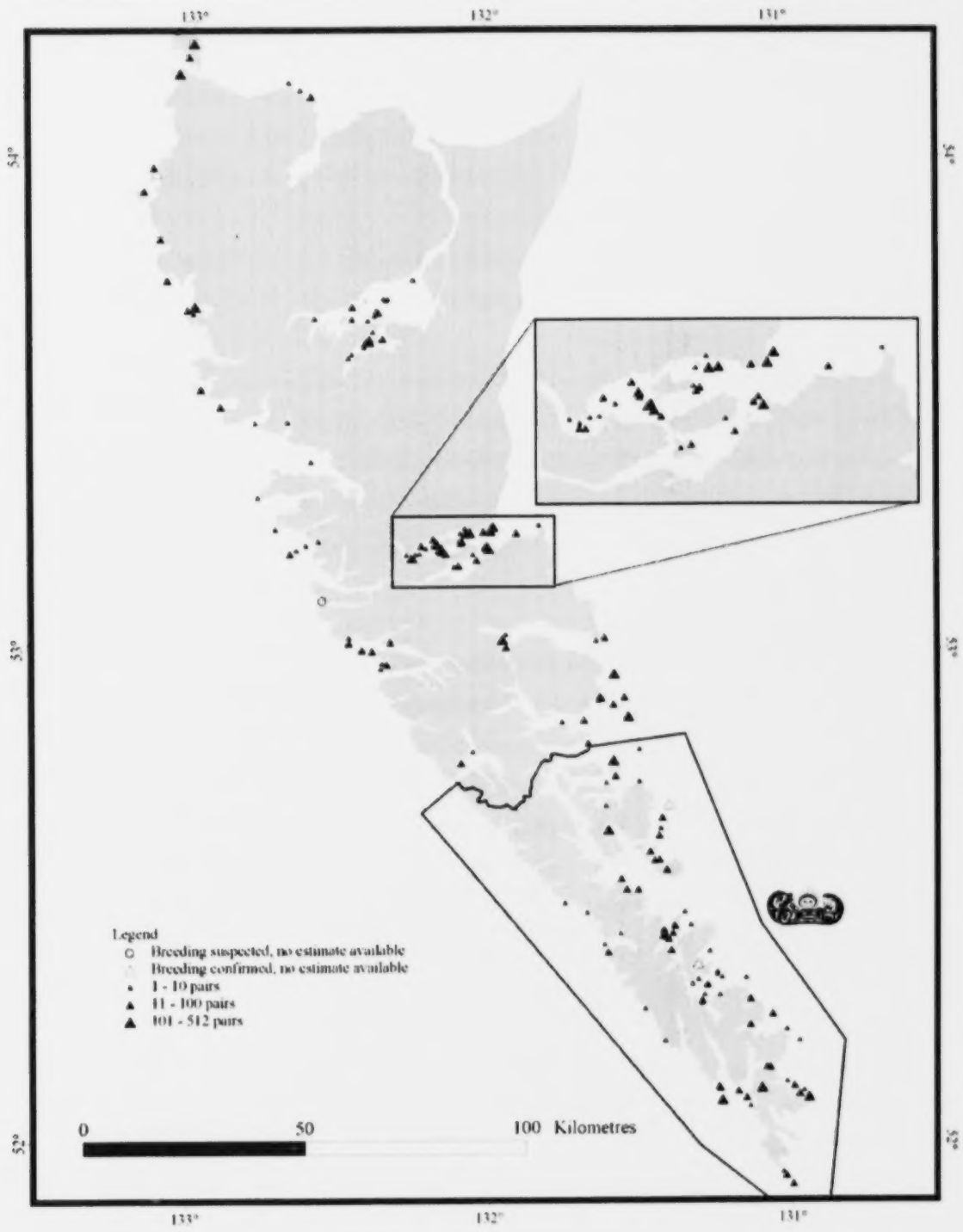


Figure 8. Numbers of Pigeon Guillemots counted on the water around probable nesting islands in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

No trend information is available for Pigeon Guillemots nesting on the archipelago. Local populations have probably been reduced by rats and/or raccoons on many islands.

Marbled Murrelet

Marbled Murrelets nest solitarily on large, mossy branches of old-growth trees. Pairs lay a single egg and incubate for about 30 days. The chick is fed small fish at the nest for 30-40 days (Burger 2002). The timing of breeding for this species in Haida Gwaii/Queen Charlotte Islands is not well documented: incubation begins near the beginning of May and chicks fledge through early September (Hamer and Nelson 1995). Most trips by parents to and from their nests are made in darkness or low light conditions. Adults prey on small schooling fish and invertebrates that are pursued underwater. On the ocean, Marbled Murrelets are usually found in protected shallow inshore waters.

Nesting Marbled Murrelets are extremely difficult to observe and fewer than 20 nests have been found on the archipelago. Population estimates for Haida Gwaii/Queen Charlotte Islands tend to be extrapolated from counts of individuals on the ocean in only a few areas of the archipelago. The relationship between number of birds on the water and number of nesting birds is unknown. Thus, population estimates should be considered highly speculative and do not represent an estimate of the number of nesting birds. A recent published estimate for the region was 8,500-9,500 Marbled Murrelets (Burger 2002). Based on information from other regions, it seems likely that Marbled Murrelets nest where suitable habitat exists throughout the old-growth forests of Graham and Moresby Islands. Habitat suitability maps have been developed for Graham and Moresby (Chytyk *et al.* 2000; McLennan *et al.* 2000; T. Golumbia, Gwaii Haanas, *personal communication*). However, the Tlell River watershed model (Chytyk *et al.* 2000) was assessed as having low reliability (Tripp 2001). A small number of Marbled Murrelets nest on some of the larger offshore islands: evidence of nesting has been reported from Langara, Chaatl, Helgesen and Burnaby Islands (A. Harfenist, *unpublished data)*. The archipelago probably supports approximately one tenth of the provincial total (Burger 2002) and less than 1% of the world population, but it is difficult to calculate the percentage because estimates from many regions vary widely.

Population trend data from Haida Gwaii/Queen Charlotte Islands are not available.

Marbled Murrelets are provincially red-listed (endangered or threatened), federally listed as "threatened" and internationally listed as "vulnerable". The main reason for federal listing was the loss of old-growth nesting habitat due to logging, but adult mortality in fishing nets and oil spills was a contributing factor (Rodway 1990; Hull 2000).

Ancient Murrelet

Ancient Murrelets are colonial burrow-nesters and their nest sites are usually found within 300 m of the shoreline on forested islands (Gaston 1992). Most pairs lay two eggs which are incubated for about 30 days. Hatching is approximately eight to eleven days later off northwestern Graham Island than off eastern Moresby Island with median hatch dates in late May to early June (Gaston and Harfenist 1998). Chicks are not fed in the burrow and leave for the ocean within a few days of hatching. Arrivals to and departures from the colony occur in darkness. The birds dive for their prey which consists mainly of large zooplankton and larval and juvenile fish. Ancient Murrelets are primarily found in offshore waters greater than 2 km from shore. During the breeding season, however, they tend to congregate near their breeding colonies from mid-afternoon through early morning.

Approximately 256,000 pairs of Ancient Murrelets nest in Haida Gwaii/Queen Charlotte Islands (Harfenist *et al.* 2002). The 33 known colony locations are shown in Figure 9. About half of the Ancient Murrelets in the archipelago nest off the west coast of Graham Island on Langara, Frederick and Hippa Islands. Haida Gwaii/Queen Charlotte Islands is the only nesting site for Ancient Murrelets in Canada and the archipelago's breeding population represents about 50% of the world total (Gaston 1994).

The total breeding population in Haida Gwaii/Queen Charlotte Islands has probably declined by about 50% since the middle of the last century (Gaston 1992). Populations have increased at some colonies that have not been exposed to introduced predators: Lihou, Reef, George, Ramsay and Frederick Islands (Lemon and Gaston 1999). However, declines or abandonments have been documented at six and ten colonies, respectively. Raccoons or rats are believed responsible for the declines on Helgesen, Saunders, Langara, Lyell, Kunghit and Limestone Islands (Bertram and Nagorsen 1995; Gaston and Masselink 1997; A. Gaston, CWS, *personal communication*).

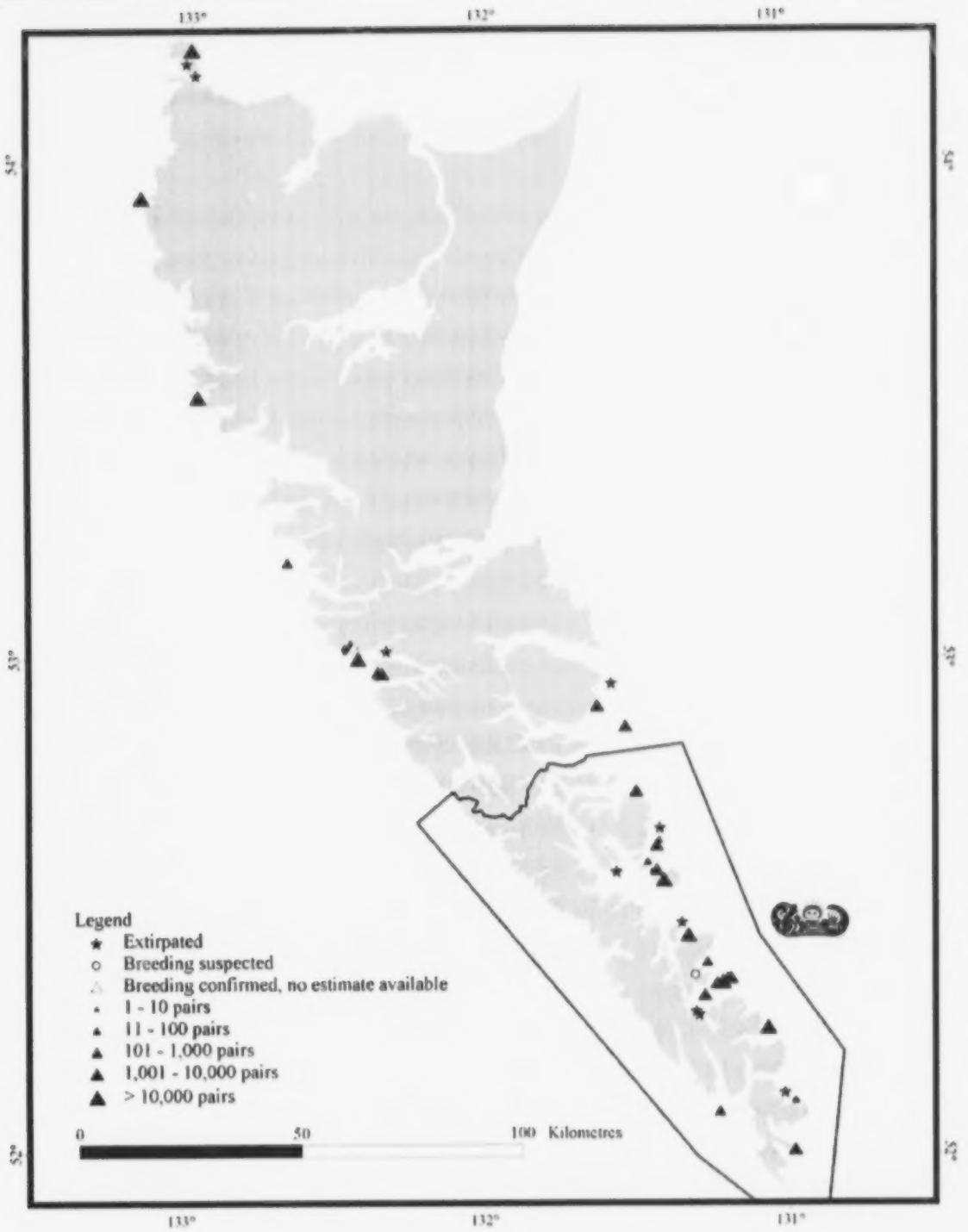


Figure 9. Locations and relative sizes of breeding colonies of Ancient Murrelets in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Abandonments of Lucy, Cox, Instructor, Boulder, Sea Pigeon, Skedans, Arichika, Bischof, Tar and High Islands are unexplained although rat or raccoon predation may have been a factor at some of these sites (Rodway 1991; Gaston 1994). Introduced predators have been eradicated from East Limestone, Langara, Helgesen and, within the last year, the Bischof Islands. The Ancient Murrelet populations have not yet recovered on East Limestone and Langara Islands (A. Gaston, CWS, *personal communication*; Drever 2000).

The Ancient Murrelet is provincially blue-listed (vulnerable) and federally listed as a "*species of special concern*". The threat to the breeding population from introduced rats and raccoons was the main reason for federal listing (Gaston 1994). Provincial listing considered the distribution of nests (a high proportion of the population concentrated at relatively few sites) as well as threats posed by introduced predators, oil spills, human disturbance mortality in gill nets and habitat loss due to logging on large islands (presumably referring to Lyell Island).

Cassin's Auklet

Cassin's Auklets nest colonially in burrows found in the forest or under grassy hummocks. Most burrows are located within 100 m of the shoreline (Vermeer and Lemon 1986; Rodway *et al.* 1988). Pairs lay a single egg which is incubated for approximately 40 days. Timing of breeding is about two weeks earlier off the east coast of Moresby than off the northwest coast of Graham: hatching occurs in late April through early June (Vermeer *et al.* 1997). During the 45 day nestling period, the main prey items supplied to the chicks by the parents during nocturnal trips are zooplankton and larval fish. Birds dive for their prey. Cassin's Auklets tend to be found on marine waters deeper than 100 m.

Cassin's Auklets are the most numerous breeding seabird in Haida Gwaii/Queen Charlotte Islands (Vermeer *et al.* 1997): an estimated 297,000 pairs nest at 45 colonies (Figure 10). The global breeding range of Cassin's Auklets is centred in British Columbia which supports approximately 80% of the world population (Rodway 1991). The archipelago total is about 18% of the world breeding population (Rodway 1991).

The population trend for the archipelago is unknown but numbers have probably declined. Declines or abandonments have been noted on seven islands: raccoons or rats are presumed responsible for the decline on Helgesen Island and the abandonment of Saunders, Langara, Cox and St. James

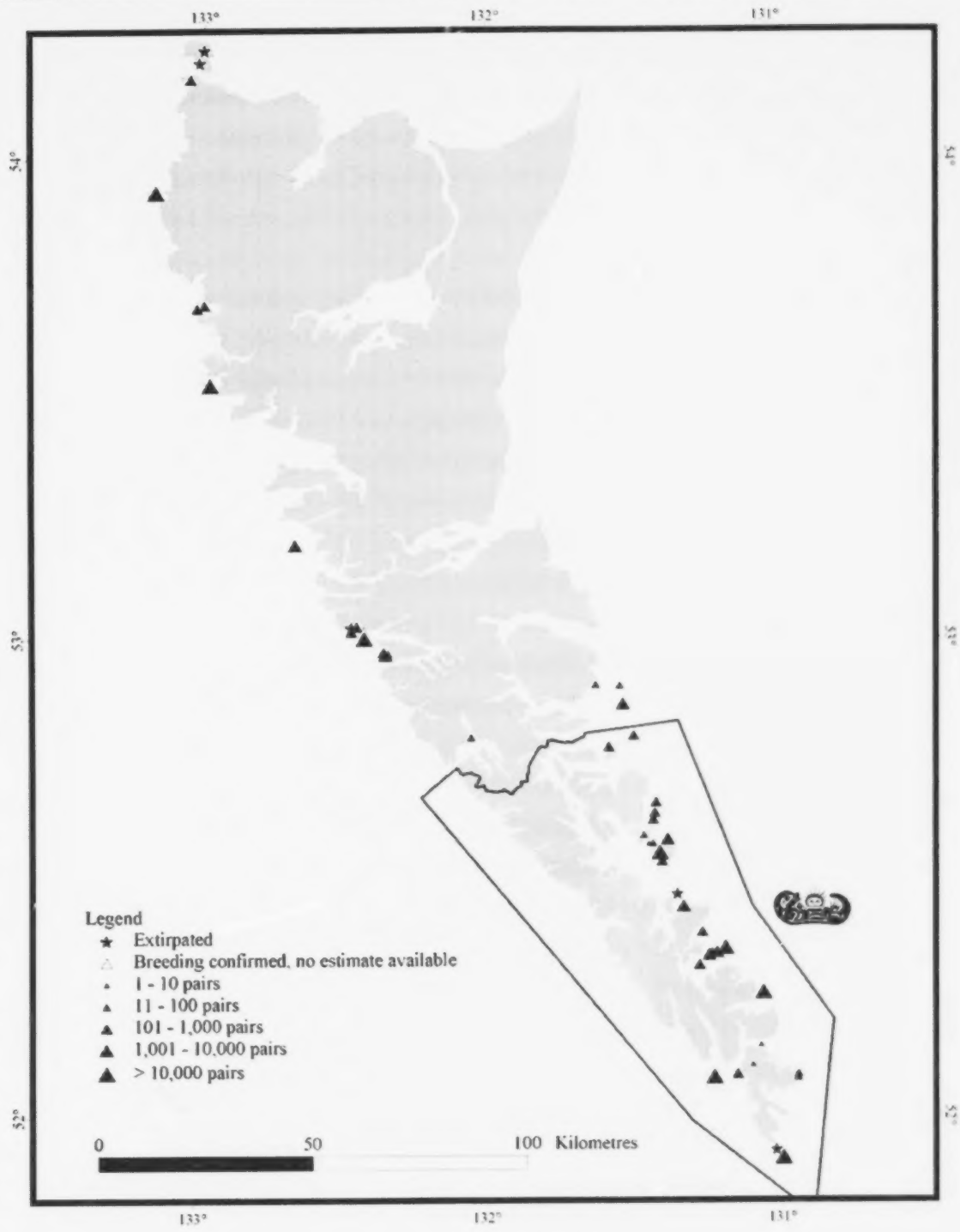


Figure 10. Locations and relative sizes of breeding colonies of Cassin's Auklets in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Islands (Rodway *et al.* 1990, 1994; Gaston and Masselink 1997). A documented decline on the Rankine Islands is probably due to a significant change in the vegetation in the areas that the birds nest (M. Lemon, CWS, *personal communication)*, whereas the decline on Arichika is unexplained. Populations on George, East Copper and Reef Islands appear to be relatively stable (Lemon 1992, 1997; A. Gaston, *personal communication*).

The species is blue-listed (vulnerable) in British Columbia because a large proportion of the population is concentrated at relatively few colonies making it vulnerable to catastrophic events such as oil spills; threats from introduced predators and human disturbance were also considered in the listing decision.

Rhinoceros Auklet

Rhinoceros Auklets nest colonially in burrows located on forested islands (Rodway *et al.* 1988, 1990). Burrows are found under grass hummocks, moss or bare soil. Pairs lay a single egg which is incubated for about 45 days. Hatching occurs from early June through early July. Chicks are fed small fish in their burrows during the approximately 50 day nestling period. Trips to and from the colonies occur in darkness. Birds pursue their prey underwater. Rhinoceros Auklets are often seen on the ocean near their colonies at dusk during the breeding season. They move further offshore during the non-breeding season..

Approximately 24,000 pairs of Rhinoceros Auklets breed Haida Gwaii/Queen Charlotte Islands (Harfenist *et al.* 2002). The 19 colonies are concentrated off the south and northwest coasts of Moresby Island (Figure 11). The archipelago supports approximately 7% and 4% of the British Columbia and global populations, respectively (Rodway 1991; Campbell *et al.* 1990 b).

The Haida Gwaii/Queen Charlotte Islands breeding population has probably declined over the last half century. Local declines and abandonments have been attributed to raccoons and rats on Langara, Cox, Saunders, Helgesen and Little Helgesen Islands (Rodway *et al.* 1990, 1994; Bertram and Nagorsen 1995; Gaston and Masselink 1997). Colonies on Ellen and Instructor Islands and two small sub-colonies on Kunghit Island have disappeared for unknown reasons (Rodway *et al.* 1988; Harfenist 1994; Gaston and Masselink 1997). The very small colonies on High and Charles Islands seem to be stable (Harfenist 1994).

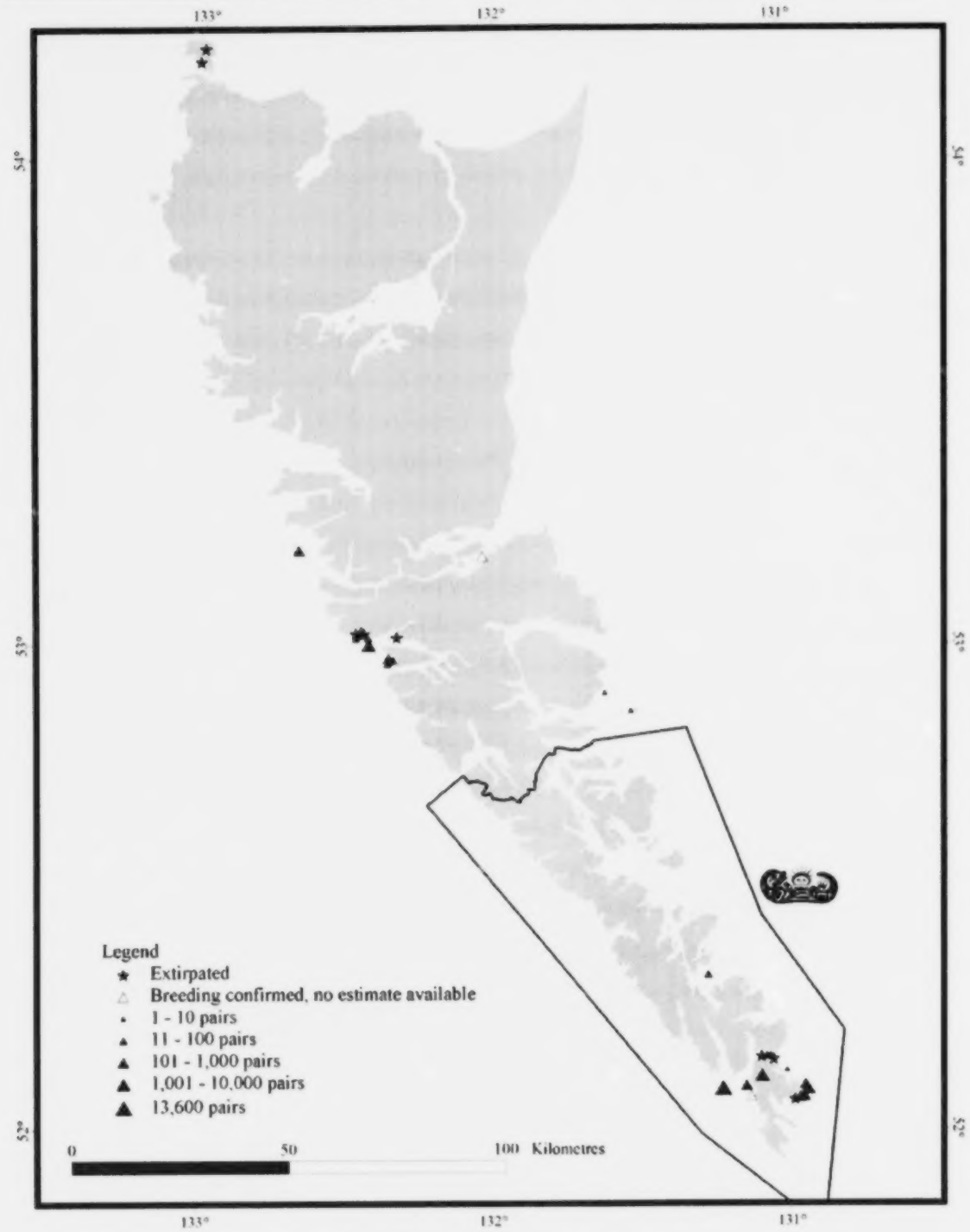


Figure 11. Locations and relative sizes of breeding colonies of Rhinoceros Auklets in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Horned Puffin

Horned Puffins nest in burrows on slopes covered with grass hummocks or in crevices. Pairs lay a single egg which they incubate for about 40 days. Timing of hatching is undocumented in the archipelago. Chicks stay in their burrows for about 42 days before going to sea. Prey includes fish, invertebrates and squid that are pursued underwater. Trips to and from the colonies are made during the day. Birds are seen on the waters around their colonies during the breeding season and move further offshore by winter.

Breeding by Horned Puffins in Haida Gwaii/Queen Charlotte Islands has not been confirmed. However, pairs have been observed entering burrows on Flatrock Island and SGaang Gwaii (Rodway *et al.* 1990; Butler 2000). Nesting is suspected at Kerouard, St. James and Marble Islands because birds are often observed on land at those locations (Campbell *et al.* 1990 b). Probable and suspected nesting sites are shown in Figure 12. The published estimate of 16 breeding pairs for the archipelago (Rodway 1991) should be considered a very rough approximation. The archipelago total is probably close to one half of the provincial total (Rodway 1991) and less than 0.01% of the North American population (Campbell *et al.* 1990 b).

There are no trend data available for the archipelago.

The species is provincially red-listed (endangered or threatened) due to the small number of breeding individuals and colonies.. Threats from oil spills, gill nets and human disturbance were noted in the listing process.

Tufted Puffin

Tufted Puffins nest colonially in burrows on slopes covered with grass hummocks or in rock crevices. Pairs lay a single egg which is incubated for about 45 days. The timing of hatch has not been described for the archipelago population. Chicks are fed small fish and zooplankton during the nestling period which lasts approximately 50 days. Prey are pursued underwater. Adults visit the colonies during the day. During the breeding season, adults are often seen on the ocean around colonies. However, for most of the year Tufted Puffins are usually found at or offshore of the continental shelf edge.

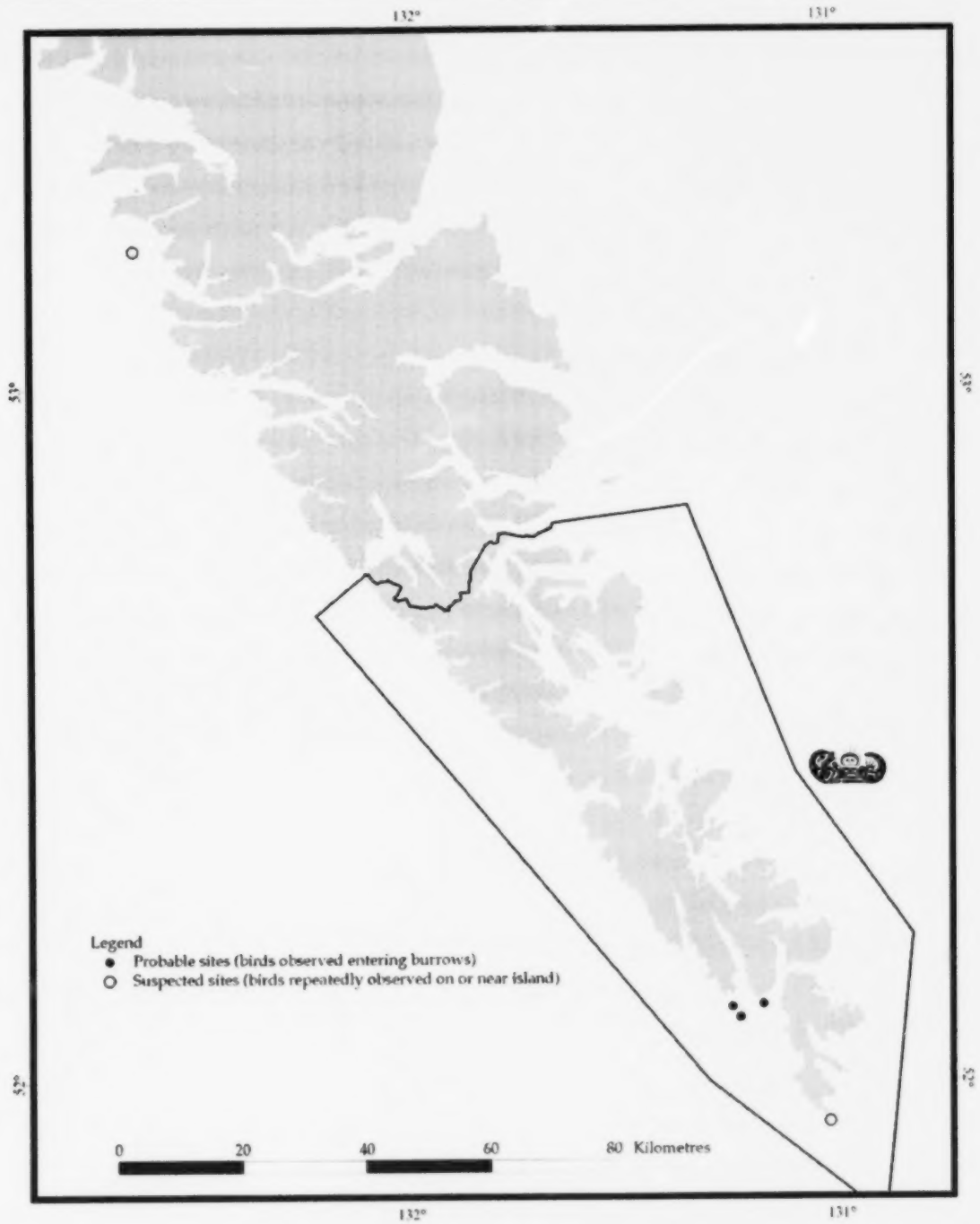


Figure 12. Locations of probable and suspected breeding colonies of Horned Puffins in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Due to the inaccessibility of most Tufted Puffin nest sites, colony estimates have been derived from counts of the number of birds standing around burrows. Thus, the published estimate of 560 pairs (Rodway 1991) should be considered a rough approximation. The 12 confirmed or suspected breeding colonies are shown in Figure 13. The archipelago supports less than 0.5% of the world population (Campbell *et al.* 1990 b).

Given the inexact nature of the population estimates for Tufted Puffins, it is difficult to determine regional trends. The abandonment of Langara Island was probably due to rat predation and rats likely impacted the population on St. James Island as well (Rodway *et al.* 1990, 1994). The SGaang Gwaii population has undergone a decline and the Tuft Islets colony was abandoned, but the causes of these changes are unknown.

Tufted Puffins are provincially blue-listed (vulnerable). The restricted distribution of breeding birds (a high proportion of birds concentrated at few colonies) renders them vulnerable to oil spills, introduced predators and large scale oceanographic change. Human disturbance and gill nets were also considered threats to this species.

THREATS TO NESTING SEABIRDS

Consideration of threats to seabirds is complicated by the fact that seabirds use both the terrestrial and marine ecosystems: during the breeding season they nest on land but continue to depend on the ocean for food. Furthermore, seabirds are migratory and may face different threats in different parts of their range. The following discussion will focus on those issues related to the birds' nesting sites in Haida Gwaii/Queen Charlotte Islands. Marine-based issues will be only briefly reviewed, but their impact on breeding seabirds should not be disregarded. A more detailed review of each issue can be found in Harfenist *et al.* (2002).

The vulnerability of seabirds to the threats discussed in this section depends on aspects of each species' biology such as the timing of trips to and from colonies (day or night) which affects risk from lights and campfires. The specific habitat used by a species is also an important variable and burrow-nesting birds have different risks than those that nest on the surface. In addition, large nesting colonies concentrate significant portions of a population at a limited number of locales, thus increasing the vulnerability of the population to a localized threat such as the introduction of rats.

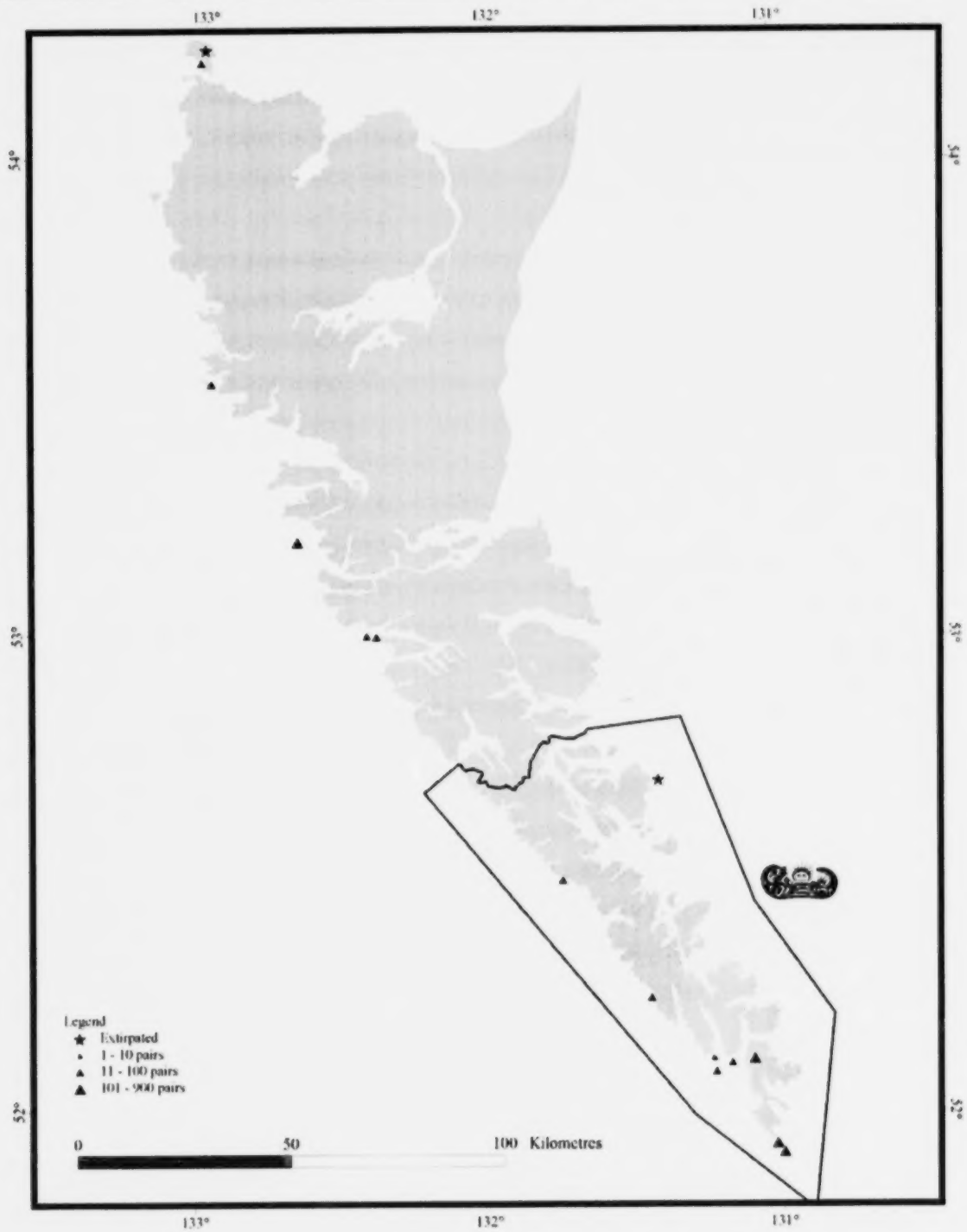


Figure 13. Locations and relative sizes of breeding colonies of Tufted Puffins in Haida Gwaii/Queen Charlotte Islands (figure taken from Harfenist *et al.* 2002).

Characteristics of seabirds that are relevant to their risk from human-induced threats were reviewed by Warheit *et al.* (1997).

Introduced Species

The most serious and immediate issue of concern for nesting seabirds in Haida Gwaii/Queen Charlotte Islands is introduced mammalian predators: raccoons (*Procyon lotor*) and rats (*Rattus* spp.; Harfenist and Kaiser 1997). These predators have caused significant reductions, and in some cases the complete loss, of breeding populations on some islands in the archipelago.

Raccoons were intentionally introduced to the archipelago as a source of fur in the mid-twentieth century. They have spread throughout Graham and Moresby Islands and to many offshore islands as well (Hartman and Eastman 1999). Raccoons have been found on eight to eleven islands that historically supported more than 50 pairs of nesting seabirds (Table 2). Based on the pattern of raccoon expansion to date, islands within 0.6 km of a source area are considered vulnerable (Gaston and Masselink 1997). At a colony, raccoons dig eggs, chicks and adults out of burrows; they also kill birds on the surface. In the presence of raccoons, Ancient Murrelet, Cassin's Auklet and Rhinoceros Auklet populations on Helgesen Island declined by 83%, 95% and 79%, respectively, over a seven year period (Gaston and Masselink 1997). Under a strategy for monitoring and controlling raccoons on seabird colonies in Haida Gwaii/Queen Charlotte Islands, key sites have been checked annually and raccoons found have been killed (Harfenist *et al.* 2000).

Rats have been accidentally introduced to Haida Gwaii/Queen Charlotte Islands from ships. The earliest introductions may have been shortly post-contact (Bertram and Nagorsen 1995). Both black rats (*R. rattus*) and Norway rats (*R. norvegicus*) are now found in the archipelago. Table 2 lists the eight large and moderate seabird colonies where rats have been recorded. Rats enter burrows to kill adults, chicks and eggs and likely kill birds on the surface as well. On Langara Island, rats completely destroyed nesting colonies of Fork-tailed Storm-petrels, Cassin's Auklets, Rhinoceros Auklets and Tufted Puffins (Bertram 1995). The Ancient Murrelet colony on the island declined from historical levels of ~200,000 pairs to ~14,600 pairs by 1993 (Harfenist 1994). Rats were eradicated from Langara and nearby Cox and Lucy Islands in 1995 (Kaiser *et al.* 1997), but the nesting populations had not shown signs of recovery by 2000 (Drever 2000). Rats have also been

Table 2. Islands/islets in Haida Gwaii/Queen Charlotte Islands with more than 50 nesting pairs of seabirds where presence of raccoons and/or rats has been documented (adapted from Table 20 in Harfenist *et al.* 2002).

Site	Raccoon +/or Rat	Nesting Seabird Species[b]
Langara I.	Rat	*Fork-tailed Storm-petrel*, Glaucous-winged Gull, Pigeon Guillemot, Ancient Murrelet, *Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin*
Cox I.	Rat	*Fork-tailed Storm-petrel, Leach's Storm-petrel*, Pigeon Guillemot, *Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet*, Tufted Puffin
Lucy I.	Rat	*Ancient Murrelet*
Saunders I.	Raccoon	Pigeon Guillemot, Ancient Murrelet, *Cassin's Auklet, Rhinoceros Auklet*
Helgesen I.	Raccoon	Fork-tailed Storm-petrel, Leach's Storm-petrel, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet
Instructor I.[a]	Raccoon	Fork-tailed Storm-petrel, Leach's Storm-petrel, Pigeon Guillemot, *Ancient Murrelet, Rhinoceros Auklet*
St. James I.	Rat	Pelagic Cormorant, Glaucous-winged Gull, Pigeon Guillemot, *Cassin's Auklet*, Tufted Puffin
Kunghit I.	Raccoon + Rat	Pelagic Cormorant, Glaucous-winged Gull, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin
Rock It.[a]	Raccoon	Fork-tailed Storm-petrel, Leach's Storm-petrel, Pigeon Guillemot, Cassin's Auklet
Skincuttle I.	Raccoon	Fork-tailed Storm-petrel, Leach's Storm-petrel, Ancient Murrelet, Cassin's Auklet
George I.[a]	Raccoon	Storm-petrel species, Ancient Murrelet, Cassin's Auklet
Alder I.	Raccoon	Storm-petrel species, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet
Ramsay I.	Raccoon	Pelagic Cormorant, Glaucous-winged Gull, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet
Bischof Is.	Rat	Storm-petrel species, Pigeon Guillemot, *Ancient Murrelet*
Murchison I.	Rat	Glaucous-winged Gull, Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet
Lyell I.	Rat	Pigeon Guillemot, Ancient Murrelet
Limestone Is.	Raccoon	Pigeon Guillemot, Ancient Murrelet, Cassin's Auklet
Skedans Is.	Raccoon	Fork-tailed Storm-petrel, Glaucous-winged Gull, Pigeon Guillemot, *Ancient Murrelet*, Cassin's Auklet

[a] Raccoon occurrence is questionable.

[b] Italicized names indicates that the species has abandoned nesting at the site; underlined names indicates that the population is known to have declined at the site.

removed from St. James Island (Golumbia 2002) and the Bischof Islands (T. Golumbia, Gwaii Haanas, *personal communication*).

Raccoons and/or rats have been recorded on numerous smaller colonies including: Sea Pigeon, Centre, Park, Swan, Ferry and Sandilands Is. (Rodway *et al.* 1988; Vermeer *et al.* 1993; Bertram and Nogorsen 1995; D. Burles, Gwaii Haanas, *personal communication*). The predators have undoubtedly reached other small colonies as well.

Other introduced species such as black-tailed deer (*Odocoileus hemionus*) and red squirrels (*Sciurus hudsonicus*) may affect nesting seabirds, but impacts have not been quantified.

Habitat Loss and Degradation

Loss and fragmentation of old-growth forests from logging and associated activities such as road-building is considered the most significant issue of concern to nesting Marbled Murrelets (Hull 2000). Logging is listed by the CDC as a threat to the nesting habitat of Ancient Murrelets as well; this probably refers primarily to the remnant colony on Lyell Island. Log salvage operations along colony shorelines may inhibit the travel of chicks by altering potential runways between the vegetation and ocean. Although Ancient Murrelets are the most vulnerable to changes caused by log salvage operations, Cassin's Auklets and Rhinoceros Auklets nesting close to the shoreline on relatively flat islands may also be affected.

Other developments that alter shorelines or the vegetation edge such as mariculture operations, fishing lodges and recreation sites may also reduce habitat or degrade the quality of remaining habitat. For example, one of the sports fishing lodges on Langara Island was built on a section of the former Ancient Murrelet colony (Vermeer *et al.* 1997).

Activities associated with forestry operations can cause the degradation of marine ecosystems as well. Logging and road-building may increase runoff and sedimentation in marine waters and thus degrade the foraging habitat of species that feed inshore. Nearshore log-handling operations may also degrade foraging habitats (Remington 1993).

Tourism and Recreation

Most tourism and much of the recreation in Haida Gwaii/Queen Charlotte Islands is coastal and overlaps the breeding seasons of seabirds. Impacts relate to disturbance of birds and damage to their nesting habitat. Surface-nesting seabirds (Pelagic Cormorant, Glaucous-winged Gull, Common Murre) often leave their nests when boats or people approach too closely. The adults may knock eggs or chicks off ledges as they hurriedly depart and unprotected eggs and chicks may be preyed on by gulls, eagles, crows and ravens (Verbeek 1982). Campfires on nesting islands can kill or injure disoriented nocturnal seabirds. Light from flashlights, lanterns and boats moored close to shore can also disorient nocturnal birds arriving at or leaving their nests; lights on land may be sufficient to prevent Ancient Murrelets chicks from fledging. People who wander off the beaches of nesting islands into the vegetated colony area may cause the collapse of burrows.

Activities associated with tourism and recreation can impact the marine habitat of seabirds as well as the nesting habitat discussed above. Boat traffic often disturbs feeding birds and this is of concern for those species that feed primarily in sheltered waters used by kayakers and small boat operators (Burger 2002). Oil contamination from boat motors can also be a problem.

Lights

Nocturnal seabirds (Fork-tailed and Leach's Storm-petrel, Ancient Murrelet, Cassin's Auklet, Rhinoceros Auklet) are attracted to and become disoriented by land-based lights at night. Injuries and mortalities from collisions with structures, ropes and wires have been documented at light stations on St. James and Langara Islands (Munro 1924). Lights associated with camping also cause collisions. Ancient Murrelet chicks leaving the colony (fledging) will run toward human lights rather than toward the ocean.

Lights on commercial fishing boats may attract or confuse nocturnal seabirds causing injury or death from collisions withy ropes and wires. At Langara Island, mortality of Ancient Murrelets associated with inshore fishing boats was significant (Bertram 1995).

Hunting

Hunting of seabirds and collection of their eggs is prohibited by law to all people except Haida who can legally hunt for food, social and ceremonial purposes. At present, the main activity that affects seabirds is collection of Glaucous-winged Gull eggs. There may be impacts at some easily accessible colonies in Skidegate Inlet.

Offshore Oil and Gas Development

Seabirds nesting in Haida Gwaii/Queen Charlotte Islands will be at risk from increased oil contamination if offshore oil and gas development proceeds in the surrounding marine waters. Mortality and injury resulting from collisions with oil platforms are also a concern (Montevecchi *et al.* 1999). Although massive mortalities following large oil spills are the most obvious effect of oil on seabirds, repeated exposure to low levels of oil pollution from ship operations (eg. bilge-pumping) or leaking pipes may present a more serious threat to seabird populations (Burger *et al.* 1997).

Lethal and sublethal impacts of oil contamination of seabirds are reviewed by Piatt *et al.* (1990), Sloan (1999) and Peterson (2001) among others. Birds can ingest toxic quantities of oil as they attempt to clean their feathers or feed on oiled prey. Oil contamination of feathers may also cause a reduction in insulating ability and buoyancy leading to death from hypothermia or drowning. Sublethal effects can include a reduction in nesting success.

Other Environmental Contaminants

Chlorinated hydrocarbons, heavy metals and plastics are contaminants of marine ecosystems that pose a threat to seabirds in Haida Gwaii/Queen Charlotte Islands. The sources, dynamics and effects on seabirds of these contaminants are reviewed in Noble (1990), Battelle Ocean Sciences (1992) and Elliott and Noble (1993). Although many of the chlorinated hydrocarbons pesticides such as DDT have been restricted in North America for many decades, they are still in use in Asia and are transported atmospherically to the marine waters in which Canadian seabirds feed (Elliott *et al.* 1997).

Levels of chlorinated hydrocarbons and heavy metals are being monitored in nesting seabirds of Haida Gwaii/Queen Charlotte Islands (Elliott and Scheuhammer 1997; Elliott *et al.* 1997), but no

data are available on the incidence of plastic in seabirds of the area. Significant direct mortalities from these contaminants are unlikely at the levels found in seabirds of the North Pacific (Noble 1990; Ohlendorf 1993). However, sublethal effects are possible. Eggshell-thinning caused by DDE (a product of DDT) leading to nesting failure is probably the best known sub-lethal effect of a pesticide. Plastic garbage has become increasingly common in the diets of seabirds of the North Pacific (Robards *et al.* 1997) and may cause a reduction in birds' weight and fat as they do not receive sufficient nutrition from their food.

Commercial Fishing

Incidental catch (bycatch) of seabirds in gillnets and longlines, over-fishing of seabird prey and disorientation of nocturnal seabirds by boat lights are the main issues of concern related to commercial fishing. The impacts of the fishing industry on seabirds are not well documented in the Haida Gwaii/Queen Charlotte Islands region. Bycatch of Ancient Murrelets and Cassin's Auklets in salmon gill nets near Langara Island during the breeding season has been recorded and likely contributed to population declines at that colony (Vermeer and Sealy 1984; Bertram 1995). The incidence of bycatch in British Columbia is reviewed by Smith (*in press*); as many as 25,000 seabirds may be killed annually in fishing gear in the province (Morgan *et al.* 1999). Diving species are at greatest risk from salmon gill nets: Common Murres, Marbled Murrelets and Rhinoceros Auklets, as well as Ancient Murrelets and Cassin's Auklets mentioned above, have been recorded in B.C. gillnets. Herring gillnet fisheries and salmon troll fisheries are not considered to be as significant a problem (Morgan *et al.* 1999). Surface feeding seabirds such as albatrosses and shearwaters are the main species at risk from longline fisheries.

Pacific herring (*Clupea pallasii*) and juvenile rockfish (*Sebastes* spp.) are important prey items for seabirds nesting in Haida Gwaii/Queen Charlotte Islands and depletion of stocks from commercial and recreational fishing are a concern (Burger *et al.* 1997). If the euphausiid (zooplankton) fishery expands to the waters around the archipelago, species that feed on plankton could be impacted (Burger 2002).

Habitat degradation as well as entanglement by seabirds in wires and nets are considered threats associated with mariculture operations (Burger *et al.* 1997). The use of anti-foulant chemicals in mariculture has also been identified as a risk for seabirds (Vermeer and Morgan 1989).

Climate Change

A discussion of the effects of global climate change on seabirds nesting in Haida Gwaii/Queen Charlotte Islands is speculative at present. Reduced survival of adult Cassin's Auklets on Frederick Island and decreased reproductive success of Ancient Murrelets in Laskeek Bay have been related to warm oceanic waters associated with El Niño events (Gaston and Smith 2001; Harfenist and Smith 2001). Impacts of ocean warming on the abundance, composition and timing of seabird prey have been documented throughout the Pacific (Veit *et al.* 1996; Anderson and Piatt 1999; Bertram *et al.* 2001).

Wind Farm Turbine Towers

Wind farms can be either land- or marine-based. The main proposal for Haida Gwaii/Queen Charlotte Islands at present involves the erection of turbines over the ocean. Very little information is available on the impacts of marine-based wind farms on seabirds; reviews by Erickson *et al.* (2001) and the Avian Working Group of the National Wind Coordinating Committee are available on the internet [http://www.nationalwind.org].

LITERATURE CITED

Acheson, S.R. 1998. In the wake of the *ya'aats' xaatgaay* [Iron People]: a study of changing settlement strategies among the Kunghit Haida. British Archaeological Reports International Series 711: 209 p.

Anderson D., and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series 189: 117-123.

AOU (American Ornithologists' Union). 2000. Forty second supplement to the American Ornithologists' Union checklist of North American birds, seventh edition. Auk 117: 847-858. [http://www.aou.org]

Battelle Ocean Sciences. 1992. Plastic pellets in the aquatic environment: sources and recommendations. U.S. Environmental Protection Agency, Oceans and Coastal Protection Division Report EPA842-B-92-010. [http://www.epa.gov/owow/OCPD/PLASTIC/contents.html]

B.C. MoWLAP (British Columbia Ministry of Water Land and Air Protection). 2002. Interim guidelines for commercial backcountry recreation in British Columbia. Prepared by the Biodiversity Branch, British Columbia Ministry of Water, Land and Air Protection, Victoria, B.C.

Bertram, D.F. 1995. The roles of introduced rats and commercial fishing in decline of Ancient Murrelets on Langara Island, British Columbia. Conservation Biology 9: 865-872.

Bertram, D.F., D.L. Mackas, and S.M. McKinnell. 2001. The seasonal cycle revisited: interannual variation and ecosystem consequences. Progress in Oceanography 49: 283-307.

Bertram, D.F., and D.W. Nagorsen. 1995. Introduced rats, *Rattus* spp., on the Queen Charlotte Islands: implications for seabird conservation. Canadian Field-Naturalist 109: 6-10.

Blackman, M.B. 1979. Northern Haida land and resource utilization: a preliminary overview. p. 43-55. In: Tales from the Queen Charlotte Islands. Vol. 1. Senior Citizens of the Queen Charlotte Islands, Masset, B.C.

Blackman, M.B. 1990. Haida: traditional culture. p. 240-260. In: Handbook of North American Indians Vol. 7. W. Suttles (ed.). Smithsonian Institution, Washington, D.C.

Burger, A.E. 2002. Conservation assessment of Marbled Murrelets in British Columbia: review of the biology, populations, habitat associations, and conservation of this threatened species. Unpublished draft (March 05, 2002), will be issued in the Canadian Wildlife Service Technical Report Series.

Burger, A.E., J.A. Booth, and K.H. Morgan. 1997. A preliminary identification of processes and problems affecting marine birds in coastal and offshore areas of British Columbia. Canadian Wildlife Service, Pacific and Yukon Region, Technical Report Series 277: 110 p.

Butler, R.W. 2000. Spring waterbirds in the Queen Charlotte Islands with notes on the Parakeet Auklet and Haida weasel. Discovery 29: 39-45.

Campbell, R.W. 1975. Seabird colonies in Skidegate Inlet, Queen Charlotte Islands, British Columbia. Syesis 8: 355-361.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990 a. The Birds of British Columbia. Volume I. Nonpasserines. Introduction and Loons through Waterfowl. Royal British Columbia Museum/Canadian Wildlife Service, Victoria, B.C. 514 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990 b. The Birds of British Columbia. Volume II. Nonpasserines. Diurnal Birds of Prey through Woodpeckers. Royal British Columbia Museum/Canadian Wildlife Service, Victoria, B.C. 636 p.

Carter, H.R., U.W. Wilson, R.W. Lowe, M.S. Rodway, D.A. Manuwal, J.E. Takekawa, and J.L. Yee. 2001. Population trends of the common murre (*Uria aalge californica)*. p. 33-132. In: Biology and conservation of the common murre in California, Oregon, Washington, and British Columbia. Volume 1: Natural history and population trends. D.A. Manuwal, H.R. Carter, T.S. Zimmerman, and D.L. Orthmeyer (eds.). United States Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD/ITR2000-0012, Washington, D.C. 132 p.

Chytyk, P., K. Dhanwant, and J.M. Cooper. 2000. Northern Goshawk and Marbled Murrelet habitat mapping for the Tlell River Watershed, Queen Charlotte Islands/Haida Gwaii, British Columbia. Unpublished report prepared for Tlell Watershed Society, Tlell, B.C.

Cumming, R.A. 1931. Some birds observed in the Queen Charlotte Islands, British Columbia. Murrelet 12: 15-17.

Drent, R.H., and C.J. Guiget. 1961. A catalogue of British Columbia seabird colonies. British Columbia Provincial Museum Occasional Paper 12: 173 p.

Drever, M. 2000. Status of Ancient Murrelet (*Synthliboramphus antiquus)* colony and upland birds following eradication of Norway rats (*Rattus norvegicus*) on Langara Island, Haida Gwaii. Unpublished report on file with the Canadian Wildlife Service, Pacific and Yukon Region, Delta, B.C. 34 p.

Elliott, J.E., P.A. Martin, and P.E. Whitehead. 1997. Organochlorine contaminants in seabird eggs from the Queen Charlotte Islands. In: The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer, and K.H. Morgan (eds.). Canadian Wildlife Service Occasional Paper 93: 137-146.

Elliott, J.E., and D.G. Noble. 1993. Chlorinated hydrocarbon contaminants in marine birds of the temperate North Pacific. p. 241-253. In: The status, ecology, and conservation of marine birds of the North Pacific. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (eds.). Canadian Wildlife Service Special Publication, Ottawa.

Elliott, J.E., and A.M. Scheuhammer. 1997. Heavy metal and metallothionein concentrations in seabirds from the Pacific coast of Canada. Marine Pollution Bulletin 34: 794-801.

Ellis, D.W. 1991. The living resources of the Haida: birds. Unpublished manuscript on file with the Haida Gwaii Museum, Skidegate, B.C. 67 p.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young, Jr., K.J. Sernka, and R.E. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparison to other sources of avian collision mortality in the United States. Report prepared for the National Wind Coordinating Committee [http://www.nationalwind.org]

Ewins, P.J. 1993. Pigeon Guillemot. The Birds of North America, No. 49. A. Poole, and F. Gill (eds.). The Academy of Natural Sciences of Philadelphia, Philadelphia, PA/The American Ornithologists' Union, Washington, D.C. 23 p.

Ewins, P.J., H.R. Carter, and Y.V. Shibaev. 1993. The status, distribution, and ecology of inshore fish-feeding alcids (*Cepphus* guillemots and *Brachyramphus* murrelets) in the North Pacific. p. 164-175. In: The status, ecology, and conservation of marine birds of the North Pacific. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (eds.). Canadian Wildlife Service Special Publication, Ottawa.

Fedje, D.W., R.J. Wigen, Q. Mackie, C.R. Lake, and I.D. Sumpter. 2001. Preliminary results from investigations at Kilgii Gwaay: an early Holocene archaeological site on Ellen Island, Haida Gwaii, British Columbia. Canadian Journal of Archaeology 25: 98-120.

Gaston, A.J. 1992. The Ancient Murrelet a natural history in the Queen Charlotte Islands. T. and A.D. Poyser, London. 249 p.

Gaston, A.J. 1994. Status of the Ancient Murrelet, *Synthliboramphus antiquus*, in Canada and the effects of introduced predators. Canadian Field-Naturalist 108: 211-222.

Gaston, A. J. (ed.). 2002. Laskeek Bay Conservation Society annual scientific report, 2001. Laskeek Bay Research 11. Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Gaston, A.J., and A. Harfenist. 1998. Timing of breeding in Ancient Murrelets: comparison of east and west coasts of Haida Gwaii, B.C. Pacific Seabirds 25: 65-67.

Gaston, A.J., and I.L. Jones. 1998. The Auks: family Alcidae. Oxford University Press, New York. 349 p.

Gaston, A.J., and M.J. Lemon. 1996. A tale of two islands: comparisons of population dynamics of Ancient Murrelets at two colonies in Haida Gwaii, British Columbia. Report of Scientific Activities for 1995. Laskeek Bay Research 6: 29-38. A.J. Gaston (ed.). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Gaston, A.J., and M. Masselink. 1997. The impact of raccoons *Procyon lotor* on breeding seabirds in Englefield Bay, Haida Gwaii, Canada. Bird Conservation International 7: 35-51.

Gaston, A.J., and J.L. Smith. 2001. Changes in oceanographic conditions off northern British Columbia (1983-1999) and the reproduction of a marine bird, the Ancient Murrelet (*Synthliboramphus antiquus*). Canadian Journal of Zoology 79: 1735-1742.

Golumbia, T. 2002. St. James rat eradication program final report. Report on file at Gwaii Haanas National Park Reserve office, Queen Charlotte, B.C. 35 p.

Gray, J. 1999. Laskeek Bay Conservation Society: report from the 1999 field season. Unpublished report on file with the Laskeek Bay Conservation Society, Queen Charlotte City, B.C. 11 p.

Gray, J. 2000. Laskeek Bay Conservation Society: report from the 2000 field season. Unpublished report on file with the Laskeek Bay Conservation Society, Queen Charlotte City, B.C. 10 p.

Hamer, T.E. and S.K. Nelson. 1995. Nesting chronology of the Marbled Murrelet. In: Ecology and conservation of the Marbled Murrelet. C.J. Ralph, G.L. Hunt Jr., M.G. Raphael, and J.F. Piatt (eds.). Pacific Southwest Research Station, Forest Service, United States Department of Agriculture, General Technical Report PSW-GTR-152: 416 p.

Harfenist, A. 1994. Effects of introduced rats on nesting seabirds of Haida Gwaii. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 218: 52 p.

Harfenist, A., and G.W. Kaiser. 1997. Effects of introduced predators on the nesting seabirds of the Queen Charlotte Islands. In: The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer, and K.H. Morgan (eds.). Canadian Wildlife Service Occasional Paper 93: 132-136.

Harfenist, A., K.R. MacDowell, T. Golumbia, G. Schultze, and Laskeek Bay Conservation Society. 2000. Monitoring and control of raccoons on seabird colonies in Haida Gwaii (Queen Charlotte Islands). p. 333-339. In: At risk: proceedings of a conference on the biology and management of species and habitats at risk. L.M. Darling (ed.). British Columbia Ministry of Environment, Lands and Parks, Victoria, B.C.

Harfenist, A., N.A. Sloan, and P.M. Bartier. 2002. Living marine legacy of Gwaii Haanas I: marine bird baseline to 2000 and marine bird-related management issues throughout the Haida Gwaii region. Parks Canada Technical Report in Ecosystem Science Report 036: 164 p.

Harfenist, A., and B. Smith. 2001. Adult and sub-adult survival rates of Cassin's Auklets at Frederick Island, British Columbia. Pacific Seabirds 28: 34 [abstract only].

Hartman, L.H., and D.S. Eastman. 1999. Distribution of introduced raccoons *Procyon lotor* on the Queen Charlotte Islands: implications for burrow nesting seabirds. Biological Conservation 88: 1-13.

Hatter, I., and L. Stordeur. 1978. An inventory of Canada Geese and seabirds nesting in Juskatla, Masset, Skidegate, and Long Inlets, Queen Charlotte Islands British Columbia. Unpublished Report, British Columbia Fish and Wildlife Branch, Skeena Region, Smithers, B.C. 43 p.

Hobson, K.A. 1997. Pelagic Cormorant. The Birds of North America, No. 282. A. Poole, and F. Gill (eds.). The Academy of Natural Sciences of Philadelphia, Philadelphia, PA/The American Ornithologists' Union, Washington, D.C. 28 p.

Hull, C.L. 2000. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report update on Marbled Murrelet *Brachyramphus marmoratus* (Gmelin). Unpublished report prepared for the Committee on the Status of Endangered Wildlife in Canada, Ottawa. 66 p.

Kaiser, G.W. 2002. Seabirds in northern British Columbia. In: Information supporting past and present ecosystem models of northern British Columbia and the Newfoundland shelf. University of British Columbia Fisheries Centre Research Reports 10(1): 85-87.

Kaiser, G.W., R.H. Taylor, P. Buck, J.E. Elliott, G.R. Howald, and M.C. Drever. 1997. The Langara Island Seabird Habitat Recovery Project: eradication of Norway rats – 1993-1997. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 304.

Lemon, M.J.F. 1992. Survey of permanent seabird monitoring plots in Skincuttle Inlet. Report on Scientific Activities for 1991. Laskeek Bay Research 2: 25-28. A.J. Gaston, A. Lawrence, and C. French (eds.). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Lemon, M. 1993 a. Survey of Ancient Murrelets at Dodge Point, Lyell Island. Laskeek Bay Research 3: 38-51. A.J. Gaston, and A. Lawrence (eds.). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Lemon, M. 1993 b. Survey of permanent seabird monitoring plots on Ramsay Island. Laskeek Bay Research 3: 52-55. A.J. Gaston, and A. Lawrence (eds.). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Lemon, M.J.F. 1997. Seabird colony monitoring on George Island, 1996. Report on scientific Activities for 1996. Laskeek Bay Research 7: 27-48. A.J. Gaston (ed.). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Lemon, M.J.F., and A.J. Gaston. 1999. Trends in Ancient Murrelet populations since 1980. Bird Trends 7: 22-25.

McLennan, D., V. Veenstra, and I. Manley. 2000. Preliminary landscape-level habitat suitability algorithms for Marbled Murrelet and Queen Charlotte Goshawk on the Queen Charlotte Islands/Haida Gwaii. Report prepared for the British Columbia Ministry of Environment, Lands, and Parks, Smithers, B.C. 36 p.

Montevecchi, W.A., F.K. Wiese, G. Davoren, A.W. Diamond, F. Huettmann, and J. Linke. 1999. Seabird attraction to offshore platforms and seabird monitoring from offshore support vessels and other ships. Literature review on monitoring designs. Environmental Studies Research Funds Report 138. Calgary, AB.

Morgan, K.H., R.C.H. Wilson, and F. Aitkens. 1999. Proceedings of a Workshop on the Bycatch of Seabirds. Institute of Ocean Sciences, Sidney, B.C. Dec. 1-2, 1998.

Munro, J.A. 1924. A preliminary report on the destruction of birds at lighthouses on the coast of British Columbia. Canadian Field-Naturalist 38: 141-175.

Noble, D.G. 1990. Environmental contaminants in Canadian seabirds. State of the Environment Report 90-2: 74 p. Environment Canada, Ottawa.

Ohlendorf, H.M. 1993. Marine birds and trace elements in the temperate North Pacific. p. 232-240. In: The status, ecology, and conservation of marine birds of the North Pacific. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (eds.). Canadian Wildlife Service Special Publication, Ottawa.

Peterson, C.H. 2001. The "*Exxon Valdez*" oil spill in Alaska: acute, indirect and chronic effects on the ecosystem. Advances in Marine Biology 39: 1-103.

Piatt, J.F., H.R. Carter, and D.N. Nettleship. 1990. Effects of oil pollution on marine bird populations. p. 125-140. In: The effects of oil on wildlife. J. White (ed.). Sheridan Press, Hanover, Pennsylvania.

Poole, A., and F. Gill (eds.). 1997. Birds of North America. The Academy of Natural Sciences, Philaelphia, PA. and the American Ornithologists' Union, Washington, D.C.

Remington, D. 1993. Coastal wetlands habitat assessment and classification for northwestern British Columbia. Unpublished report prepared for the Pacific Estuary Conservation Program, B.C.

Robards, M.D., P.J. Gould, and J.F. Piatt. 1997. The highest global concentrations and increased abundance of oceanic plastic debris in the north Pacific: evidence from seabirds. p. 71-80. In: Marine debris: sources, impacts, and solutions. J.M. Coe, and D.B. Rogers (eds.). Springer, New York.

Robinson, C.L.K., R. Douglas, and D.M. Ware. 1999. A synthesis of oceanographic and biological information for Gwaii Haanas NMCA continental shelf ecosystems. Report prepared for Gwaii Haanas National Park Reserve, Queen Charlotte, B.C. by Northwest Ecosystem Institute, Lantzville, B.C. 122 p.

Rodway, M.S. 1988. British Columbia Seabird Colony Inventory: Report 3 – census of Glaucous-winged Gulls, Pelagic Cormorants, Black Oystercatchers and Pigeon Guillemots in the Queen Charlotte Islands, 1986. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 43: 95 p.

Rodway, M.S. 1990. Status report on the Marbled Murrelet in Canada. Unpublished report to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Ottawa. 59 p.

Rodway, M.S. 1991. Status and conservation of breeding seabirds in British Columbia. p. 43-102. In: Seabird status and conservation: a supplement. J.P. Croxall (ed.). International Council for Bird Protection Technical Publication 11. Cambridge, U.K.

Rodway, M.S., M.J.F. Lemon, and G.W. Kaiser. 1988. British Columbia Seabird Colony Inventory: Report 1 – east coast Moresby Island. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 50: 276 p.

Rodway, M.S., M.J.F. Lemon, and G.W. Kaiser. 1990. British Columbia Seabird Colony Inventory: Report 2 – west coast Moresby Island. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 65: 163 p.

Rodway, M.S., M.J.F. Lemon, and G.W. Kaiser. 1994. British Columbia Seabird Colony Inventory: Report 6 – major colonies on the west coast of Graham Island. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 95: 108 p.

Sloan, N.A. 1999. Oil impacts on cold-water marine resources: a review relevant to Parks Canada's evolving marine mandate. Parks Canada - National Parks Occasional Paper 11: 67 p. [http://www.parkscanada.gc.ca/library/DownloadDocuments/]

Smith, J.L. 1998. Report on scientific activities at the Laskeek Bay Conservation Society field camp in 1997. Laskeek Bay Research 8: 2-9. A.J. Gaston (ed). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Smith, J.L. 2000. Counts of Glaucous-winged Gulls breeding in Laskeek Bay. Laskeek Bay Research 9: 27-28. A.J. Gaston (ed). Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Smith, J.L. 2003. A review of seabird by-catch in longline and gill net fisheries in British Columbia 1995-2000. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series *in press*.

Summers, K.R. 1974. Seabirds breeding along the east coast of Moresby Island, Queen Charlotte Islands, British Columbia. Syesis 7: 1-12.

Tripp, T. 2001. A synopsis of Marbled Murrelet habitat suitability models in BC. Report on file with the British Columbia Ministry of Water, Land and Air Protection, Habitat Branch, Victoria, B.C. 35 p.

Veit, R.R., P. Pyle, and J.A. McGowan. 1996. Ocean warming and long-term change in pelagic bird abundance within the California current system. Marine Ecology Progress Series 139: 11-18.

Verbeek, N.A.M. 1982. Egg predation by Northwestern Crows: its association with human activity and Bald Eagle activity. Auk 99: 347-352.

Verbeek, N.A.M. 1993. Glaucous-winged Gull. The Birds of North America, No. 59. A. Poole, and F. Gill (eds.). The Academy of Natural Sciences of Philadelphia, Philadelphia, PA/The American Ornithologists' Union, Washington, D.C. 13 p.

Vermeer, K., K. Devito, and L. Rankin. 1988. Comparison of nesting biology of Fork-tailed and Leach's Storm Petrels. Colonial Waterbirds 11: 46-57.

Vermeer, K., A. Harfenist, G.W. Kaiser, and D.N.Nettleship. 1997. The reproductive biology, status, and conservation of seabirds breeding on the Queen Charlotte Islands: a summary. In: The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer, and K.H. Morgan (eds.). Canadian Wildlife Service Occasional Paper 93: 58-77.

Vermeer, K., and M. Lemon. 1986. Nesting habits and habitats of Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands, British Columbia. Murrelet 67: 34-44.

Vermeer, K., and K.H. Morgan. 1989. Mariculture and bird interactions in the Strait of Georgia. p.174-176. In: The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. K. Vermeer, and R.W. Butler (eds.). Canadian Wildlife Service Special Publication.

Vermeer, K., K.H. Morgan, M. Bentley, F. Goodfellow, and N. Beattie. 1991 b. The importance of spring staging areas of Brant (*Branta bernicla)* and the distribution of other marine birds near Sandspit, Queen Charlotte Islands. Canadian Wildlife Service, Pacific and Yukon Region Technical Report Series 136: 27 p.

Vermeer, K., K.H. Morgan, and G.E.J. Smith. 1993. Colony attendance of Pigeon Guilemots as related to tide height and time of day. Colonial Waterbirds 16: 1-8.

Vermeer, K., K.H. Morgan, G.E.J. Smith, and B.A. York. 1991 a. Effects of egging on the reproductive success of Glaucous-winged Gulls. Colonial Waterbirds 14: 158-165.

Vermeer, K., and S.G. Sealy. 1984. Status of nesting seabirds of British Columbia. p. 29-40. In: Status and conservation of the world's seabirds. J.P. Croxall, P.G. Evans, and R.W. Schreiber (eds.). International Council for Bird Protection Technical Publication No. 2. Cambridge. U.K. 778 p.

Warheit, K.I., C.S. Harrison, and G.J. Divoky (eds.). 1997. *Exxon Valdez* oil spill seabird restoration workshop. Pacific Seabird Group Technical Publication No. 1. 171 p.

Appendix A. The common, Haida and scientific names[a] of seabird species that nest in Haida Gwaii/Queen Charlotte Islands.

Common Name	Northern Haida Name	Southern Haida Name	Scientific Name
Fork-tailed Storm-petrel	st'quana	jiik'iiga, sdaagwaana, jiik'iida	*Oceanodroma furcata*
Leach's Storm-petrel	st'quana	jiik'iiga, sdaagwaana, jiik'iida	*Oceanodroma leucorhoa*
Pelagic Cormorant	kelow	k'yaaluu	*Phalacrocorax pelagicus*
Glaucous-winged Gull	skun		*Larus glaucescens*
Common Murre		gwaah	*Uria aalge*
Pigeon Guillemot	skadwa	sgaaxudaawa, jaadxaws, sgaaxadawaa	*Cepphus columba*
Marbled Murrelet	tilum	ts'alang.ah	*Brachyramphus marmoratus*
Ancient Murrelet	saduna	sgin xaana, skin xaana	*Synthliboramphus antiquus*
Cassin's Auklet	hutso	hajaa	*Ptychoramphus aleuticus*
Rhinoceros Auklet		hlagwaats'ii	*Cerorhinca monocerata*
Horned Puffin			*Fratercula corniculata*
Tufted Puffin	quana	kuxana	*Fratercula cirrhata*

[a] Common and scientific names are from the American Ornithologists Union's *Checklist of North American Birds* (AOU 2000); northern Haida names are from Cumming (1931) based on phonetic interpretation of "Masset Haida dialect"; southern Haida names are according to the Skidegate Haida Immersion Program of the Skidegate Haida Language Authority (as cited in Appendix 3, Harfenist *et al.* 2002).

Appendix B. Recommendations for management of seabird colonies in Haida Gwaii/Queen Charlotte Islands

Most seabirds require islands free from introduced mammalian predators for nesting. In addition, nesting areas and adjacent shorelines should be free of most human disturbances during the breeding season. Gill nets should not be set in inshore areas near colonies of diving birds. Nocturnal species also require inshore marine areas free of lights.

The following management options are recommended to protect breeding populations of Fork-tailed Storm-petrels, Leach's Storm-petrels, Pelagic Cormorants, Glaucous-winged Gulls, Pigeon Guillemots, Ancient Murrelets, Cassin's Auklets, Rhinoceros Auklets, Horned Puffins and Tufted Puffins. Marbled Murrelets require a different management regime.

1) Provide formal protection to colony sites not presently protected in Gwaii Haanas National Park Reserve/Haida Heritage Site, Ecological Reserves or Wildlife Management Areas:

- Protect all areas with active nesting and adjacent shorelines;
- Include a 200 m buffer around the nesting areas to protect the integrity of the habitat;
- Clearly mark protected sites on marine and recreation maps and include a notation that human access is restricted.

2) Maintain the integrity of the birds' nesting habitat:

- Restrict access to nesting habitat including camping and other recreational activities on colonies during the breeding season;
- Prevent development on or adjacent to nesting areas;
- Prohibit logging on nesting islands;
- Restrict development of the centre of large colony islands to as required to protect the nesting habitat from degradation..

3) Maintain nesting islands free of introduced predators:

- Monitor vulnerable colonies for raccoons and remove the mammals from islands when found;
- Remove rats from colony islands where feasible.

4) Ensure that petrel and alcid adults and chicks have unobstructed access to the ocean from the nesting areas:

- Prevent permanent development (including sports fishing lodges, mariculture operations, log sorts) of shoreline, intertidal zone and inshore marine waters;
- Prevent activities that alter the habitat (including log salvage operations, camping) along the shoreline, intertidal zone and inshore marine waters during the nesting season.

5) Reduce injury and mortality to breeding seabirds and their eggs and young on or near the nesting sites:

- Restrict commercial and sports fishing activities in marine waters adjacent to the nesting areas during the breeding season;
- Restrict light pollution near colonies during the breeding season;
- Restrict campfires near colonies during the breeding season;
- Avoid placing mooring buoys in inshore marine waters around colonies to prevent contamination from chronic oil pollution;

- Place a 500 m buffer around Pelagic Cormorant nesting ledges during the breeding season, as recommended in the B.C. Ministry of Water, Land and Air Protection guidelines for backcountry recreation (B.C. MoWLAP 2002), to prevent disturbance from recreational activities that flush adults from the nest.

The above recommendations should be considered for sites from which seabirds have been extirpated by introduced mammalian predators to allow the recovery of breeding populations.

Marbled Murrelets probably nest throughout much of the remaining old-growth forests on Graham and Moresby Islands. Protection of their nesting habitat will require areas where logging is restricted.

For all species, healthy prey stocks and undisturbed access to marine foraging grounds are important.